

GENERATIVE RELATIONAL ECONOMICS

VOLUME VII

Research Programme, Disciplinary Interfaces,
Limits, and Open Development

PROGRAMME • INTERFACES • OPEN DEVELOPMENT

WANHONG HUANG

GENERATIVE RELATIONAL ECONOMICS

Seven-Volume Treatise

Volume VII

**Research Programme, Disciplinary
Interfaces, Limits, and Open
Development**

Chapters 22–25

Wanhong Huang

huangwanhong@serendip.ngo

Copyright

Generative Relational Economics

Volume VII: Research Programme, Disciplinary Interfaces, Limits, and Open Development

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Series Structure

Generative Relational Economics is organized as a seven-volume treatise. Chapter numbering remains continuous across the series.

Volume I. *Foundations, Constitution, and Ontology of Generative Relational Economics* (Chapters 1–4)

Volume II. *Epistemology, Research Praxis, and Relational Inquiry* (Chapters 5–7)

Volume III. *Generative Relational Inquiry and Integrated Research Design* (Chapters 8–9)

Volume IV. *Application-Dominant Praxis, Intervention, and Economic Architecture* (Chapters 10–12)

Volume V. *Allocation, Value, Spacetime, Power, and Epistemic Economy* (Chapters 13–17)

Volume VI. *Artificial Intelligence, Domains, and Economic Order* (Chapters 18–21)

Volume VII. *Research Programme, Disciplinary Interfaces, Limits, and Open Development* (Chapters 22–25)

The seven-volume division is a physical and editorial organization of the same continuous manuscript. Existing chapter identities, section numbering, notation, bibliography records, and conceptual architecture are preserved. The additional physical volume allows the edition to remain within the publisher's 1,050-page ceiling without compressing the typography or splitting chapters.

Preface

This book develops *Generative Relational Economics* (GRE) as an open research programme for studying economic life through relations, generative processes, historical transformation, heterogeneous forms of value, and the conditions under which present arrangements alter future possibilities. Its point of departure is economic, but the questions that must be answered before a relational-generative economics can be stated coherently are broader. A theory of economic relations requires a view of what kinds of realities may be treated as analytically real; claims about those realities require an epistemology; empirical work requires a research praxis and methodology; and economic intervention requires an account of decision and action under incomplete knowledge. The book therefore develops a limited set of broader Generative Relational (GR) foundations before returning to substantive economics.

The resulting architecture should not be read as a claim that economics contains ontology, epistemology, history, law, governance, aesthetics, or the other domains with which it interacts. The opposite discipline governs the project. A domain remains defined by its principal problem-space while retaining explicit interfaces with neighboring domains. GRE draws historical insight from generative relational approaches to history, governance insight from neighboring work on generative relational governance, and normative and aesthetic resources where economic questions require them. Those interfaces remain interfaces. They do not dissolve the boundaries among disciplines.

The central economic concern is the generation and transformation of relational possibilities. Conventional allocation questions remain important, but an allocation does more than change holdings. It may stabilize or weaken relations, generate capacities, alter access, reshape institutions, change the pathways through which heterogeneous values circulate, and modify what later actors are able to do. GRE therefore follows resources beyond the administrative recipient and asks how economic interventions enter relational structures and how those structures develop through time.

This orientation also changes the treatment of value. The book does not assume that all values can be placed in a single common metric. Material, capability, relational, epistemic, institutional, future, and other forms of value may interact without becoming fully commensurable. Their conversion is therefore an economic problem in its own right. GRE asks what happens at conversion interfaces, which actors can define or control those interfaces, what is lost or generated in conversion, how value circulates and returns, and how power and justice appear when heterogeneous values move through unequal relational systems.

Historical time is equally central. Economic processes operate across different temporal scales. Transactions, prices, attention, organizational routines, institutions, trust structures, infrastructures, and intergenerational capacities need not change at comparable rates. The book consequently treats trajectories, delayed generation, path dependence, multiple timescales, and

cross-scale coupling as economic objects rather than as secondary complications. Formal descriptions such as dynamical systems, networks, fields, geometry, category-theoretic structures, or spacetime-like representations are used where they clarify such problems. They remain analytical representations whose scope must be justified locally; they do not establish the ultimate ontology of social or economic reality.

The book also treats research itself as praxis. Historical, interpretive, qualitative, quantitative, empirical, formal, and computational methods provide partially irreducible modes of access to relational-generative systems. Their relation is therefore neither a hierarchy nor a simple synthesis. They can expose one another's blind spots, constrain one another's overreach, and generate revisions of concepts and theories. Research-dominant praxis and application-dominant praxis are likewise related configurations rather than separate worlds. Research contains decisions and interventions; application contains inquiry and learning. Their principal tensions differ, and either may transform into the other as the practical situation changes.

Artificial intelligence makes several of these questions more urgent. Large asymmetries in productive and epistemic capability may persist even where material output becomes abundant. Such asymmetries raise economic questions about ownership, dependence, participation, access, value capture, research orientation, and the relation between productive contribution and social membership. GRE approaches these questions without assuming that capability equality is either possible or desirable. The relevant issue is how heterogeneous capabilities enter relations and how those relations convert asymmetry into power, exclusion, participation, or new generative possibilities.

The programme offered here is deliberately revisable. Earlier GR formulations, including earlier historical and formal proposals, are treated as intellectual resources rather than canonical premises. A useful distinction may later fail in another domain; a formal analogy may lack empirical warrant; a theory may require a narrower scope; an apparently general GR structure may turn out to be economics-specific. Revision is therefore part of the framework's normal development rather than an exceptional repair.

For the same reason, GRE is presented in dialogue with existing economics rather than as a replacement for it. Neoclassical, Marxian, Keynesian, institutional, evolutionary, complexity, feminist and care, capability, ecological, commons, relational, and other traditions have developed objects, mechanisms, methods, and normative distinctions that GRE can learn from. A relational language may sometimes make translation among these traditions possible. Translation does not imply theoretical identity. Some disagreements should remain visible because they concern different ontologies, values, methods, scales, or historical commitments.

The book is consequently best read as an architecture for continuing inquiry. It makes substantive claims, proposes hypotheses, develops conceptual distinctions, and offers formal and methodological resources, while marking open problems and places where counterevidence would require revision. Its intended endpoint is not a closed economic system. It is a research programme capable of entering new relations, being altered by them, and preserving enough of its own history for later readers to understand how those alterations occurred.

Standing of the Work

This volume is a book-length statement of Generative Relational Economics as a developing research programme. Its standing is stronger than that of a preliminary note and weaker than that of a closed theoretical system. The distinction matters because the chapters contain several kinds of intellectual object whose evidential and argumentative status differs.

A *claim* is a proposition for which the book supplies an argument at the level required by its local purpose. A *proposal* identifies a conceptual or theoretical structure offered for further assessment. A *hypothesis* states a mechanism or relation whose standing ultimately depends on empirical, historical, or formal investigation beyond the argument that motivates it. A *heuristic* organizes inquiry without asserting that the represented structure literally constitutes the world. A *formal representation* specifies a mathematical or structural language under explicit assumptions. These categories should remain distinct throughout the manuscript.

The broader GR material in the book has a similarly limited standing. GRE is the principal domain. General ontological, epistemological, research-practical, and application-practical foundations are developed only to the degree required to construct GRE. The volume does not claim to provide a completed Generative Relational Theory across all disciplines. A more general theory would require sustained comparison across independently developed domains, including cases in which concepts useful in economics fail, change meaning, or become unnecessary elsewhere.

Ontological suspension provides the default discipline for that reason. Relational reality and manifestation reality are treated as analytically meaningful without requiring a final metaphysical settlement for every object under study. Formal language may sharpen a relational description, but formal usefulness does not by itself establish ontological identity. A field representation, a network, a dynamical system, a category-theoretic mapping, or a spacetime-like model earns its place through the question it helps answer and the evidence or interpretation to which it can be connected.

The historical standing of the programme is equally important. Earlier GR and GRH formulations are open to correction. The present book may retain an earlier distinction, weaken it, change its status from ontology to heuristic, or set it aside. Such changes should remain reconstructable rather than being hidden by retrospective rewriting. The research programme therefore values provenance, versioned concepts, preservation of negative results, and future re-epistemization.

GRE also declines several forms of premature closure. It assumes no single universal metric of value, no predetermined historical endpoint, no universal formalism, and no methodological monopoly. Generativity itself is not treated as automatically good. A process can generate capacities, relations, or options while also producing domination, extraction, exclusion, or

harm. Normative evaluation therefore remains an independent task informed by, rather than mechanically derived from, generative description.

The volume's relationship to existing economics is dialogical. Existing theories can correct GRE, delimit its scope, or supply better explanations for particular problems. GRE can also provide a comparative relational language through which theories that foreground different objects or scales may encounter one another. The success of such translation must be assessed case by case. Failed translation is itself informative because it identifies theoretical specificity that a common language should not erase.

The same discipline governs application. The book develops application-dominant praxis because economic actors often must decide before knowledge is complete. Decisions remain epistemically regulated, historically situated, normatively contestable, and revisable where reversal is possible. Practical closure is therefore distinguished from epistemic closure. Acting under uncertainty does not convert uncertainty into knowledge; it establishes a provisional commitment whose consequences become part of the next epistemic situation.

The work should therefore be evaluated at several levels: the coherence of its conceptual distinctions, the adequacy of its reconstructions, the quality of its dialogue with existing theories, the warrant of its formal representations, the empirical tractability of its hypotheses, and the practical usefulness of the questions it makes available. No single success at one level secures the others. The open research programme begins from that plurality of burdens.

Guide to the Book

The book is organized into eight Parts. The sequence is cumulative, although individual chapters can be read independently when a reader already accepts the foundations on which they rely.

Part I: Foundations and Constitution of Generative Relational Economics. The opening Part reconstructs the historical conditions under which GRE becomes necessary and possible, surveys the intellectual resources from which it can be constructed, and defines GRE as an emerging economic research programme. The emphasis is disciplinary: the Part explains the problem-space before introducing the broader GR foundations required later.

Part II: Ontology and Epistemology. The second Part develops the ontological view and epistemology used by the remainder of the book. Ontological suspension, relational reality, manifestational reality, representation, evidence, and the limits of inverse inference establish the conditions under which later economic claims can be made without converting analytical representations into final metaphysical commitments.

Part III: Research Praxis and Methodology. The third Part treats research as a historically situated form of praxis. It develops methodological pluralism across historical, interpretive, qualitative, quantitative, empirical, formal, and computational inquiry; then it develops methods for relational inquiry, generative relational inquiry, and integrated research design. Readers primarily interested in empirical or formal GRE can use this Part as the methodological gateway to the substantive economic chapters.

Part IV: Application-Dominant Praxis and Methodology. The fourth Part shifts the principal practical tension from understanding toward decision and intervention under incomplete knowledge. It develops action spaces, practical judgment, risk, reversibility, participation, responsibility, adaptive intervention, and the methodological instruments used for decision and institutional change. Research and application remain coupled throughout.

Part V: Foundations of Substantive Generative Relational Economics. The fifth Part returns fully to the economic domain. It develops the relational architecture of economic systems, allocation as relational intervention, generative and heterogeneous value, and generative spacetime. This Part contains the main conceptual machinery for following resources and values through relational structures across time and scale.

Part VI: Power, Knowledge, and Artificial Intelligence. The sixth Part develops several major consequences of substantive GRE. Power and justice are examined through asymmetry, conversion, capture, participation, and generative opportunity. The epistemic economy extends the analysis to knowledge abundance, attention, curiosity, aesthetic judgment, and research orientation. The final chapter of the Part examines artificial intelligence under radical capability and knowledge asymmetry.

Part VII: Domains and Economic Synthesis. The seventh Part examines selected domains in which GRE can be tested, translated, and limited. The purpose is not to absorb education, research institutions, humanitarian practice, communities, commons, ecology, or other domains into economics. Domain work identifies where GRE is useful, where neighboring theories are required, and where apparently general concepts become domain-specific. The Part concludes with a synthesis of the economic orders made thinkable by GRE.

Part VIII: Dialogue, Research Programme, and Disciplinary Return. The final Part turns the framework back toward economics as a discipline. Existing economic traditions are reconstructed in relational dialogue without ranking or forced unification. The book then states a GRE research programme, identifies interfaces with neighboring GR domains, records limits and open problems, and closes with GRE's standing as an open and historically revisable programme rather than a finished canon.

Readers can therefore enter the book at different points. A reader interested in foundations should begin with Parts I and II. A methodological reader can move from Chapter 6 through Chapter 11. A reader primarily interested in GRE's economic contribution can begin with Part V and return to the earlier foundations as needed. Readers concerned with AI, epistemic economy, power, or justice may begin in Part VI, while Part VIII provides the most direct account of GRE's relationship to existing economics and its future research agenda.

Cross-references are used to keep these entry points possible without pretending that the chapters are independent. Concepts are introduced where they first become structurally necessary, and later chapters should reuse rather than silently redefine them. Where a concept changes status or scope, the revision should be stated explicitly.

AI Assistance Statement

Artificial intelligence has been used as an assistive research and writing instrument in the development of this book. Its uses include structural planning, language revision, comparison of alternative organizations, code generation for manuscript tooling, compilation support, exploration of formal representations, and assistance in maintaining consistency across a long and evolving project.

AI assistance does not function as an evidential authority. External references are subject to a pre-verification rule: a source must be checked against an authoritative or reliable online record and against the claim it is intended to support before the citation is inserted into the manuscript. Bibliographic verification, claim selection, theoretical commitments, normative judgments, and responsibility for the final text remain with the author.

The use of AI is also treated as part of the book's substantive research problem. Abundant generation of prose, models, hypotheses, and technically difficult questions does not eliminate the need for research judgment. Problem selection, historical sensitivity, relational interpretation, aesthetic judgment, normative responsibility, and decisions about theoretical significance remain distinct tasks even when generative capacity is extensively automated.

Because the project is developed through iterative human–AI interaction, intermediate drafts may contain exploratory formulations that are later revised or abandoned. The standing of the published text is determined by the final human-reviewed manuscript rather than by any individual intermediate generation. Revision histories and project materials are preserved where useful so that the development of the programme remains reconstructable.

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Chapter 22

Research Programme of Generative Relational Economics

Research Architecture and Chapter Scope

Chapter 22 converts the open programme state established at the close of Chapter 21 into an explicit architecture for cumulative inquiry. Chapter 21 treated theoretical dialogue as a source of research questions, contradiction profiles, empirical and formal gaps, normative remainders, domain tests, and revision pressures. The present chapter organizes those outputs into a research programme capable of supporting theoretical development, empirical testing, historical reconstruction, interpretive inquiry, formal modeling, comparative analysis, application, counterevidence, replication, and infrastructure building. Its role within Part VIII is therefore architectural and programmatic: it specifies how GRE can remain a revisable body of inquiry rather than a completed conceptual system.

The chapter has four principal objectives. First, it separates the status of GRE claims so that arguments established within the book, proposals, hypotheses, illustrations, domain-specific claims, contested claims, and open questions are not treated as epistemically interchangeable. Second, it develops substantive research streams around relational economic architecture, allocation, heterogeneous value, value conversion and circulation, generative return, generative spacetime, fast-slow dynamics, power, justice, exploitation, epistemic economy, artificial intelligence, and domain studies. Third, it specifies methodological programmes spanning formal, historical, interpretive, quantitative, empirical, comparative, and intervention-oriented inquiry. Fourth, it establishes the corrective infrastructure of the programme through measurement research, counterevidence, negative results, replication, reinterpretation, research repositories, and cross-domain interfaces.

The chapter does not prescribe a single methodological sequence. GRE concerns objects whose evidential accessibility, temporal depth, scale, institutional embedding, and normative significance differ substantially. A relational architecture may require archival reconstruction before quantitative measurement becomes meaning-

ful; a proposed conversion mechanism may admit formalization before reliable parameterization; an intervention may generate evidence only if the institutional conditions that sustain the relevant relations are interpreted adequately. The research programme therefore treats methodological plurality as an architecture of mutually corrective access rather than as a menu from which methods can be selected independently of the research object.

The chapter also distinguishes programme openness from indefinite conceptual expansion. An open research programme requires explicit revision conditions. Claims must be able to become narrower, more differentiated, historically indexed, empirically weakened, formally reformulated, transferred to another disciplinary domain, or withdrawn. Negative results and failed translations therefore belong to the programme alongside successful extensions. The capacity to preserve such outcomes is part of cumulative inquiry because it prevents later work from repeatedly reconstructing discarded assumptions or treating unresolved framework debt as established knowledge.

The internal sequence begins with the architecture of the research programme and the status of GRE claims. It then develops substantive research streams, followed by domain studies and method-oriented programmes. The later sections address intervention, measurement, falsification and counterevidence, negative results, replication and reinterpretation, and shared research infrastructure. The chapter closes by identifying questions that should pass from GRE into neighboring Generative Relational domains rather than being resolved inside economics by disciplinary expansion. The resulting programme is intentionally versioned: its structure should be revised when evidence, theory, history, normative inquiry, or domain knowledge changes the support for its present organization.

The chapter's guiding discipline is therefore answerability. GRE becomes a research programme to the extent that its claims can be located within explicit research streams, connected to evidence and methods appropriate to their objects, exposed to counterevidence, and revised through documented procedures. Section 22.1 establishes that architecture before the chapter turns to claim status and individual research domains.

22.1 Architecture of the GRE Research Programme

The role of this section is to establish the organizational architecture through which the substantive and methodological research streams of Chapter 22 can develop cumulatively. Its objective is to distinguish the principal programme layers, specify the interfaces among them, and identify the conditions under which results in one layer can revise work in another. The discussion proceeds through theoretical, empirical, formal, historical, interpretive, applied, comparative, and open-programme architectures. The method is programmatic and meta-analytical: the section organizes research relations and correction pathways rather than resolving the substantive research questions developed in later sections.

Chapter 21 closed by defining a GRE research programme as an organized set of research streams, interfaces, revision procedures, evidence regimes, domain tests, and open-problem records. The present section develops that architecture at a finer resolution. A research programme requires more than a list of topics because theo-

retical claims, observations, models, historical reconstructions, interpretations, interventions, and comparisons constrain one another in different ways. The programme should make those dependencies visible. A formal model can sharpen a mechanism while remaining weakly connected to evidence; an empirical regularity can challenge a theoretical claim without identifying a replacement mechanism; historical inquiry can reveal that a supposedly general category is period-specific; interpretive work can show that an operational measure has changed the meaning of the object being measured. Architecture is therefore the structure that allows heterogeneous findings to become mutually corrective.

Definition 22.1 (Programme layer). A *programme layer* is a differentiated region of the GRE research programme organized by a principal mode of inquiry, evidential access, or research function while remaining connected to other layers through explicit interfaces.

Definition 22.2 (Research module). A *research module* is a bounded unit of inquiry that specifies a research object, a claim or question, relevant assumptions, an evidential or interpretive strategy, expected outputs, and conditions under which the result should revise dependent work.

Definition 22.3 (Programme interface). A *programme interface* is an explicit relation through which the output, assumption, limitation, or revision of one research module becomes relevant to another module or programme layer.

Interfaces are necessary because methodological plurality can otherwise become parallelism. A historical account and a formal model can coexist without affecting one another even when the model depends on a category whose historical stability the historical inquiry contests. An empirical study can use a proxy that interpretive work shows to be institutionally ambiguous. An applied intervention can generate outcomes that challenge a theoretical mechanism while leaving the mechanism unchanged in later writing. The purpose of programme architecture is to reduce these disconnects without forcing every inquiry into a common method.

Definition 22.4 (Programme dependency). A *programme dependency* is a relation in which the admissibility, interpretation, scope, or revision of one research result depends materially on another result, assumption, definition, or evidential finding.

Proposition 22.5 (Dependency visibility condition). *Where a GRE claim relies materially on another theoretical, empirical, formal, historical, interpretive, or normative result, the dependency should be represented explicitly enough that later revision of the supporting result can propagate to the dependent claim.*

This proposition makes versioned revision possible. A programme whose dependencies remain implicit can accumulate incompatible layers because later findings do not reach the claims that rely on them. Table 22.1 summarizes the principal layers developed in this section and the characteristic corrections each can provide.

22.1.1 Theoretical Architecture

The theoretical architecture organizes GRE claims so that conceptual development remains distinguishable from empirical support and formal representation. Theoretical work includes the specification of analytical objects, relations among concepts, candidate mechanisms, scope conditions, and dependencies among propositions. Its function is neither to shield GRE from evidence nor to convert every empirical pat-

Table 22.1: Principal layers of the GRE research programme

Programme layer	Principal research object	Characteristic output	Characteristic correction
Theoretical	Concepts, mechanisms, claim dependencies	Scoped propositions, mechanism families, conceptual distinctions	Conceptual revision, mechanism replacement, scope contraction
Empirical	Observable implications and identification	Measurements, estimates, cases, empirical regularities	Evidential weakening, operational revision, domain qualification
Formal	Representations and transformation rules	Models, proofs, simulations, structural comparisons	Representation revision, formal retreat, assumption clarification
Historical	Temporal formation and path dependence	Genealogies, sequences, institutional histories	Historical indexation, category revision, causal reordering
Interpretive	Meaning, situated understanding, institutional semantics	Interpretations, meaning structures, actor categories	Semantic correction, manifestation revision, contextual qualification
Applied	Interventions and institutional arrangements	Pilots, governance designs, monitoring records	Mechanism correction, feasibility revision, unintended-effect identification
Comparative	Cross-theory, cross-domain, and cross-case relations	Comparison matrices, transfer tests, explanatory contrasts	Bounded generalization, preserved disagreement, domain deference
Open programme	Revision, preservation, and research governance	Version records, negative-result archives, portfolios, dependency maps	Framework contraction, stream reorganization, claim withdrawal

tern into a general concept. It provides a revisable structure within which claims can be stated strongly enough to be investigated and weakly enough to be corrected.

Definition 22.6 (Theoretical programme layer). The *theoretical programme layer* is the organized set of GRE concepts, distinctions, mechanisms, scope conditions, and claim dependencies that determine what the framework currently proposes and how those proposals relate to one another.

A central problem is dependency. Generative value, conversion, circulation, return, power, exploitation, generative spacetime, and AI-era capability asymmetry are not independent topics. A claim about conversion power can depend on a particular account of heterogeneous value and institutional control; a claim about exploitation can depend on how return and option foreclosure are defined; a claim about delayed generation can depend on a particular temporal representation. The theoretical architecture should make such relations inspectable.

Definition 22.7 (Claim-dependency graph). A *claim-dependency graph* is a represen-

tation of how GRE definitions, assumptions, propositions, hypotheses, and domain-specific claims support, constrain, or qualify one another.

The graph need not imply that the entire theory can be reduced to a single formal structure. Its purpose is practical: when a foundational distinction changes, researchers should be able to identify which downstream claims require review. The graph can also reveal framework debt when many later claims depend on an unresolved conceptual node.

Proposition 22.8 (Theoretical modularity condition). *GRE should preserve sufficient theoretical modularity that revision of one mechanism or domain claim does not require global framework revision unless the relevant dependency relations justify that propagation.*

Theoretical modularity supports both stability and correction. If every local failure were interpreted as failure of the entire programme, empirical inquiry would become artificially high-stakes. If local failures never propagated, the programme could become immunized against evidence. Dependency-sensitive modularity offers a middle architecture in which consequences follow the actual structure of reliance.

Definition 22.9 (Mechanism family). *A mechanism family is a set of related candidate mechanisms that address a common research object while differing in assumptions, scale, historical conditions, or causal pathways.*

Mechanism families are useful where GRE currently has broad relational language but several plausible local mechanisms. Value capture, for example, can occur through ownership, contract, platform intermediation, control of recognition, control of conversion interfaces, or institutional exclusion. Treating these as a family prevents a broad term such as capture from substituting for mechanism specification. Later empirical work can then compare members of the family rather than testing a vague umbrella claim.

Proposition 22.10 (Theory-to-research condition). *A theoretical GRE claim is research-ready when its analytical object, principal mechanism or relation, relevant scope conditions, and plausible revision triggers are specified with enough precision to guide at least one empirical, historical, interpretive, formal, comparative, or applied inquiry.*

The theoretical layer therefore supplies questions and distinctions to other layers while receiving correction from them. Its quality should be judged partly by this reciprocity: concepts should make inquiry possible, and inquiry should retain the capacity to alter the concepts.

22.1.2 Empirical Programme

The empirical programme connects GRE claims to observations while treating observability as a research problem rather than a transparent bridge. Many GRE objects are relational, temporally extended, or only partially manifested in standard datasets. A relation can be present without being recorded; a value form can affect action without possessing a stable monetary measure; a future option can be foreclosed without appearing as a realized outcome. Empirical work must therefore specify what is observed, what remains latent, and which inference connects the two.

Definition 22.11 (Empirical anchor). *An empirical anchor is an observable event, record, relation, measurement, or patterned manifestation that constrains the inter-*

pretation or support of a GRE claim.

An empirical anchor need not be a single scalar variable. It can consist of linked administrative records, longitudinal relational data, institutional documents, observed transactions, network changes, interviews, or mixed evidence. The relevant requirement is that the anchor places an external constraint on the claim rather than merely illustrating it.

Definition 22.12 (Observability map). An *observability map* records which components of a GRE research object are directly observed, indirectly inferred, represented through proxies, structurally missing, or presently inaccessible.

Observability maps are especially important for relational inquiry because missingness can be theoretically structured. Administrative systems may record formal ownership while omitting informal dependence; platforms may record interaction while withholding ranking rules; household data may record income while obscuring internal allocation; ecological datasets may represent aggregate stocks while missing local relational effects. Missingness should therefore enter the research design rather than remain an unnoticed property of the dataset.

Definition 22.13 (Identification burden). The *identification burden* is the set of inferential conditions that must hold for observed manifestations to support a proposed GRE mechanism or relational claim rather than plausible alternatives.

Proposition 22.14 (Empirical correction condition). *When empirical evidence weakens an identification condition, contradicts a predicted relational pattern, or reveals systematic unobserved structure, the dependent GRE claim should be revised at the level implicated by the evidence rather than protected through broader relational description.*

This condition gives empirical inquiry a corrective role. Empirical research is not a final stage in which an already completed theory receives examples. It can change object definitions, expose omitted mechanisms, narrow scope, or demonstrate that a proposed distinction has limited observable consequences in the domain studied.

Definition 22.15 (Empirical programme portfolio). An *empirical programme portfolio* is a deliberately heterogeneous set of empirical designs used to test a GRE research object across different data regimes, domains, timescales, and identification strategies.

Portfolio design reduces dependence on one evidential regime. A relational claim supported only by cross-sectional network data may change when longitudinal histories or institutional records are introduced. A generativity claim inferred from realized outcomes may change when option loss, delayed effects, or failed trajectories are included. Later sections of this chapter therefore treat measurement and counterevidence as programme components in their own right.

22.1.3 Formal Programme

The formal programme develops representations that make selected GRE structures precise enough for deduction, simulation, comparison, or empirical parameterization. Formalization can clarify assumptions and reveal consequences that prose leaves implicit. Its value depends on correspondence between the chosen representation and the research object. GRE therefore treats formal plurality as a consequence of object heterogeneity rather than as a search for one privileged mathematical language.

Definition 22.16 (Formal research module). A *formal research module* is a bounded mathematical or computational representation whose objects, transformations, assumptions, interpretation, and intended evidential interface are explicitly stated.

Possible modules include dynamical systems, stochastic processes, network and hypergraph models, field representations, algebraic structures, category-theoretic mappings, geometric and spacetime representations, and agent-based models. Their availability does not establish their adequacy. A network can represent interaction topology while omitting the meaning of relations; an agent-based model can reproduce a macro-pattern through assumptions that remain empirically weak; a field representation can clarify distributed influence while exceeding what current evidence can identify.

Definition 22.17 (Representation adequacy). *Representation adequacy* is the degree to which a formal representation preserves the distinctions, mechanisms, scales, and observable implications that are material to the research question for which it is used.

Proposition 22.18 (Formal plurality condition). *Where materially different representations preserve different relevant structures of the same GRE research object, the formal programme should compare those representations rather than presuming that one formalism exhausts the object.*

Model comparison is therefore internal to the programme. Two models can agree on a phenomenon while disagreeing on mechanism, scale, or historical interpretation. Such agreement should not be treated automatically as validation of either representation. The programme should ask which observations or interventions discriminate between them and which remainders each leaves outside formalization.

Definition 22.19 (Formal retreat). *Formal retreat* is a documented reduction in the scope, precision, or ontological interpretation of a formal model when its assumptions or representational commitments exceed available theoretical or empirical support.

Proposition 22.20 (Formal correction condition). *A formal result should revise GRE only within the scope warranted by the interpretation and assumptions of the model that produced it; failure of those assumptions should permit formal retreat without requiring abandonment of the broader research object.*

This preserves the distinction between a useful representation and a claim about ultimate ontology. Formal research becomes cumulative when models can be compared, parameterized, falsified locally, revised, or retired while the programme records what each representation successfully clarified.

22.1.4 Historical Programme

The historical programme investigates how economic objects, categories, institutions, relations, and capacities become possible and how their present forms inherit prior trajectories. GRE's emphasis on history-bearing configurations requires more than adding time indices to otherwise static objects. Historical inquiry can show that categories such as property, labor, firm, household, market, care, platform, data, or public authority have changed in meaning and institutional organization. It can also identify sequences through which present asymmetries or conversion interfaces were generated.

Definition 22.21 (Historical programme layer). The *historical programme layer* is

the organized investigation of temporal formation, institutional sequence, conceptual change, path dependence, inherited structure, and historically specific scope conditions relevant to GRE claims.

Definition 22.22 (Historical index). A *historical index* specifies the period, institutional formation, conceptual regime, or sequence conditions within which a GRE object or claim is intended to hold.

Historical indexing does not imply that every claim is unique to one period. It makes the portability of a claim explicit. A relational mechanism can recur across periods while depending on differently constituted entities or institutions. Conversely, similar terminology can conceal different mechanisms. Historical research is therefore required both to identify continuity and to prevent false continuity.

Proposition 22.23 (Historical correction condition). *When historical reconstruction shows that a GRE category, mechanism, or boundary depends on institutions or meanings absent outside a particular formation, the claim should be historically indexed before being generalized further.*

Definition 22.24 (Genealogical dependency). A *genealogical dependency* is a relation in which the present operation or intelligibility of an economic configuration materially depends on prior institutional, conceptual, legal, technological, ecological, or political developments.

Genealogical dependencies can be causal without being deterministic. Present arrangements may retain inherited rules, infrastructures, classifications, or distributions while remaining open to change. The historical programme therefore studies both persistence and transformation. It also supplies correction to formal and empirical work when those layers treat historically produced categories as fixed units.

22.1.5 Interpretive Programme

The interpretive programme addresses economic realities whose operation depends partly on meaning, classification, expectation, legitimacy, identity, norm, or situated understanding. Such objects are not exhausted by actors' verbal reports, but their meaning cannot always be reconstructed from external behavior alone. Money, trust, care, obligation, property, professional authority, platform status, institutional membership, and public legitimacy can involve manifestational and relational dimensions whose interpretation affects economic action.

Definition 22.25 (Interpretive research object). An *interpretive research object* is an economic object or relation for which situated meanings, classifications, normative understandings, or institutional semantics materially affect its operation or evidential interpretation.

Definition 22.26 (Interpretive evidence). *Interpretive evidence* consists of records, practices, texts, narratives, categories, observations, or situated accounts used to reconstruct the meanings and institutional understandings relevant to an economic configuration.

Interpretive evidence can correct measurement. A dataset may classify two transactions identically even when participants understand one as reciprocal support and the other as debt. A platform metric may represent participation while users understand the relevant action as coerced visibility work. A legal category may define ownership while customary practice distributes use and responsibility differently. These

differences can alter the mechanism under study.

Proposition 22.27 (Interpretive adequacy condition). *Where the operation of a GRE object depends materially on situated meaning or institutional semantics, an inquiry that omits those meanings should state the resulting interpretive remainder and limit its claims accordingly.*

Definition 22.28 (Interpretive correction). An *interpretive correction* is a revision to a GRE object, mechanism, measurement, or scope condition produced by evidence that its prior representation mischaracterized the meanings or categories through which the configuration operates.

The interpretive programme therefore has equal status as a corrective layer. It is not merely preparation for later quantitative work. Some questions concern the constitution of the object itself and remain partly interpretive even after measurement becomes possible.

22.1.6 Applied Programme

The applied programme examines how GRE-informed analysis interacts with interventions, organizational arrangements, institutional design, governance, and professional practice. Application is a source of evidence because intervention exposes mechanisms to conditions that theoretical reconstruction alone may not reveal. It also carries ethical and political burdens because interventions can alter the relations whose effects they seek to study.

Definition 22.29 (Application interface). An *application interface* is the explicit connection between a GRE research claim and an intervention, institutional decision, governance process, or professional practice through which the claim informs action and receives feedback from its consequences.

Applied research should distinguish analysis from prescription. A finding that certain relational conditions support capability formation does not determine how resources ought to be distributed among competing claims. A diagnosis of asymmetric conversion power does not by itself specify a legitimate institutional remedy. The application interface should therefore record both causal expectations and normative premises.

Definition 22.30 (Intervention dossier). An *intervention dossier* records the target configuration, intended mechanism, affected parties, expected benefits and harms, reversibility, monitoring design, decision authority, uncertainty, and revision conditions associated with a GRE-informed intervention.

Proposition 22.31 (Application feedback condition). *Where an intervention informed by GRE produces outcomes inconsistent with its expected mechanism, the discrepancy should enter the theoretical and empirical programme as evidence requiring explanation rather than being treated solely as implementation failure.*

Implementation failure remains possible, but it is itself a research object. An intervention may fail because enabling relations were absent, because power altered participation, because institutional meaning changed the mechanism, because effects were delayed, or because the initial causal account was wrong. Applied work should preserve these alternatives long enough to investigate them.

Proposition 22.32 (Reversibility preference under uncertainty). *Under substantial uncertainty about relational and long-horizon consequences, applied GRE research*

should generally prefer interventions whose scale, monitoring, and reversibility preserve opportunities for learning and correction, subject to the ethical requirements and urgency of the domain.

This proposition does not make reversibility a universal normative rule. Some harms require urgent or irreversible action, and some institutional changes cannot be meaningfully piloted. It states a research-design preference when uncertainty is material and reversible learning is feasible.

22.1.7 Comparative Programme

The comparative programme extends the discipline developed in Chapter 21 from theoretical dialogue to empirical cases, domains, institutions, histories, and formal representations. Comparison is useful when the dimensions of comparability are stated explicitly. Without such specification, a common relational vocabulary can make heterogeneous cases appear more similar than their mechanisms warrant.

Definition 22.33 (Comparative programme unit). A *comparative programme unit* is a study design that specifies the cases, theories, domains, models, or historical formations being compared; the dimensions on which comparison is warranted; and the remainders that should remain outside the comparison.

Definition 22.34 (Transfer claim). A *transfer claim* is a proposition that a concept, mechanism, measurement, formal representation, or intervention result developed in one setting retains specified meaning and support in another setting.

Transfer claims require evidence because similarity of labels is insufficient. Trust relations in a scientific collaboration, a care institution, a platform market, and a monetary system may share some expectation structure while differing in authority, reciprocity, exit, dependency, and sanction. Comparative research should determine which dimensions travel and which remain domain-specific.

Proposition 22.35 (Comparative specification condition). A *comparative GRE claim* should identify its comparison dimensions, scale, historical scope, and relevant remainder before treating similarity or difference as theoretically informative.

Definition 22.36 (Comparative revision loop). A *comparative revision loop* is a sequence in which a concept or mechanism is compared across settings, its common and divergent features are identified, and the original formulation is revised to reflect the resulting scope evidence.

Comparative work thus contributes directly to theoretical architecture. It can produce bounded generalization, differentiated mechanism families, domain interfaces, or explicit non-transferability. The absence of transfer is itself informative when the programme records why a concept fails outside its originating conditions.

22.1.8 Open Programme

The final architectural layer concerns the governance of openness. An open programme requires more than a declaration that revision is possible. It needs practices that preserve claim status, negative results, alternative interpretations, framework debt, version histories, disciplinary boundaries, and unresolved disagreement. Openness is therefore an institutional property of research organization as much as an intellectual attitude.

Definition 22.37 (Open-programme governance). *Open-programme governance* is the set of procedures through which GRE records claim status, dependencies, revisions, negative results, unresolved disagreements, research priorities, domain boundaries, and conditions for entry, modification, or retirement of research modules.

Definition 22.38 (Programme portfolio). A *programme portfolio* is a versioned collection of active, suspended, completed, contradicted, and retired research modules together with their dependencies and evidential status.

A portfolio differs from an agenda because it retains failed and suspended work. This preservation is important for cumulative inquiry. A negative result can constrain later model development; a failed operationalization can prevent repeated measurement error; a non-transferable concept can define a domain boundary; a withdrawn claim can explain why later versions of GRE adopt a narrower architecture.

Definition 22.39 (Openness condition). The *openness condition* is satisfied when programme procedures permit materially supported evidence or argument to revise, differentiate, contract, suspend, transfer, or withdraw GRE claims and preserve an inspectable record of that change.

Proposition 22.40 (Open-programme correction condition). *A GRE research architecture should treat framework contraction, methodological change, formal retreat, domain deference, and claim withdrawal as admissible programme outcomes when they improve correspondence between the framework and available support.*

This condition protects the programme against expansion bias. A generative framework can be tempted to interpret every new object as an opportunity for incorporation. Openness requires the complementary capacity to recognize where another discipline should retain primary explanatory authority, where a concept has limited transportability, or where available evidence does not support the desired level of abstraction.

Definition 22.41 (Programme coherence). *Programme coherence* is the degree to which active GRE research modules maintain explicit relations among claim status, evidence, methods, domain scope, dependencies, and revision procedures without requiring theoretical uniformity.

Proposition 22.42 (Architectural coherence condition). *A plural GRE research programme remains coherent when its research modules can disagree in method, representation, or local theory while their scopes, interfaces, dependencies, and revision consequences remain sufficiently explicit for cumulative correction.*

The architecture established in this section therefore does not seek methodological or theoretical homogeneity. Its function is to make heterogeneity governable as research. Theoretical, empirical, formal, historical, interpretive, applied, and comparative work can proceed at different rates and with different evidential standards while remaining connected through explicit programme interfaces. The open-programme layer preserves those relations over time.

Section 500 can now address the next requirement: the epistemic status of individual GRE claims. Research architecture specifies where inquiry occurs and how results communicate; claim-status architecture specifies what level of confidence and argumentative force each result is presently entitled to carry.

22.2 Status of GRE Claims

The role of this section is to establish the epistemic-status architecture required by the research programme developed in Section 22.1. Its objective is to distinguish the kinds of support carried by different GRE statements and to specify how their status should constrain wording, evidential burden, downstream use, and revision. The discussion proceeds through established arguments, proposals, hypotheses, illustrative constructions, domain-specific claims, open claims, contested claims, and revision-dependent claims. The method is epistemic and programmatic: the section does not reassess every claim made in earlier chapters individually, but defines a status system through which those claims can be classified, audited, and updated.

A research programme becomes difficult to revise when statements with different epistemic standing are presented in a common declarative register. A definition introduced for analytical convenience, a proposition derived from explicit assumptions, a historically grounded interpretation, an empirically testable hypothesis, a schematic example, and a normative proposal can all appear syntactically similar while supporting very different inferences. GRE therefore requires a claim-status architecture that travels with the claim through later theoretical, empirical, formal, historical, interpretive, and applied work.

Definition 22.43 (Claim status). A *claim status* is a versioned classification of the present epistemic standing of a GRE statement relative to its assumptions, supporting arguments or evidence, domain scope, dependencies, and revision conditions.

Definition 22.44 (Status provenance). *Status provenance* is the inspectable record of the assumptions, arguments, evidence, interpretations, formal results, or prior claims that justify assigning a particular status to a statement.

Definition 22.45 (Status-bearing claim). A *status-bearing claim* is a proposition used in the research programme in a way that can support, constrain, motivate, or revise further inquiry and therefore requires an explicit account of its present epistemic standing.

Definitions themselves require a related but distinct discipline. A stipulated definition is not ordinarily verified in the same manner as an empirical proposition. Its adequacy depends on analytical clarity, consistency, usefulness, compatibility with the object of inquiry, and the costs of the distinctions it introduces or suppresses. A formal definition can therefore be internally precise while remaining open to conceptual revision.

Proposition 22.46 (Status propagation condition). *Where a downstream GRE claim depends materially on an upstream status-bearing claim, the downstream claim should not inherit greater epistemic strength than the dependency permits without additional independent support.*

The propagation condition constrains cumulative argument. A hypothesis can contribute to a model or application, but its provisional standing should remain visible in the resulting conclusion. A domain-specific empirical result can motivate a broader hypothesis, but it does not by itself establish a general law. A contested interpretation can organize inquiry while remaining contested. Table 22.2 summarizes the eight principal statuses developed in this section.

Table 22.2: Principal epistemic statuses of GRE claims

Status	Warranted use	Required support	Characteristic revision route
Established argument	Supports dependent reasoning within stated assumptions	Explicit derivation, argument, or sufficiently strong evidence within the book's scope	Reopen premises, derivation, evidence, or scope
Proposal	Organizes inquiry or recommends an analytical architecture	Stated rationale, intended function, alternatives, and limitations	Compare alternatives and revise design
Hypothesis	Guides discriminating empirical, historical, or formal inquiry	Testable or otherwise discriminating implications and scope conditions	Confirm, differentiate, weaken, or reject
Illustrative construction	Clarifies a possibility, mechanism, representation, or distinction	Internal coherence and transparent illustrative purpose	Replace when misleading or unproductive
Domain-specific claim	Supports inference within a bounded setting	Evidence and assumptions appropriate to the specified domain	Narrow, extend, or block transfer
Open claim	Marks unresolved but researchable content	Clear uncertainty and identifiable route for further inquiry	Resolve, split, suspend, or retire
Contested claim	Represents a live disagreement with material alternatives	Explicit source of disagreement and competing warrants	Adjudicate, preserve plurality, or redefine scope
Revision-dependent claim	Remains usable while materially relying on unstable upstream support	Visible dependency and revision trigger	Propagate upstream revision

22.2.1 Established Arguments

The strongest status used in the present book is an argument established within a stated analytical setting. This category is deliberately narrower than universal truth. A conclusion can be established relative to explicit definitions, assumptions, derivations, evidence, and interpretive premises while remaining revisable when any of those supports changes.

Definition 22.47 (Established-within-book argument). An *established-within-book argument* is a conclusion for which the book provides an explicit and presently adequate argumentative, formal, empirical, historical, or interpretive warrant under identifiable assumptions and scope conditions.

The qualifier “within the book” carries substantive epistemic weight. It identifies the relevant warranting structure and avoids transforming internal argumentative success into a claim of exhaustive empirical validation. Some established arguments are conceptual. For example, once the framework distinguishes relational reality from manifestational access, particular non-entailments follow from that distinction. Other established arguments may be formal and conditional on stated assumptions.

Still others may be historically or empirically supported at a level sufficient for the local purpose while remaining open to stronger external testing.

Definition 22.48 (Internal establishment). *Internal establishment* is the status achieved when a conclusion follows adequately from premises, definitions, evidence, or interpretive commitments that the book has itself made explicit and defended for the relevant purpose.

Proposition 22.49 (Internal-establishment scope condition). *Internal establishment warrants downstream use only within the assumptions, evidential range, scale, historical setting, and conceptual architecture that support the argument, unless additional work establishes broader transfer.*

This condition is particularly important for formal propositions. A proposition proved or derived within a model may be established as a formal result while the empirical adequacy of the model remains open. Likewise, an interpretive reconstruction can be established as a coherent reading supported by specified evidence without eliminating alternative interpretations.

Definition 22.50 (Established claim envelope). An *established claim envelope* is the explicit set of assumptions, domains, scales, temporal conditions, evidential supports, and conceptual commitments within which an established argument is warranted for use.

A claim can therefore lose established status through several routes: evidence can change, assumptions can fail, a definition can be revised, a historical boundary can become visible, a formal derivation can contain an error, or a stronger competing explanation can alter the interpretation of the same evidence. Establishment is compatible with revisability because the status concerns present warrant, not immunity from future correction.

Proposition 22.51 (Established-claim revision condition). *An established GRE claim should be reopened when materially relevant support within its claim envelope is withdrawn, contradicted, reinterpreted, or shown to depend on an omitted condition that changes the conclusion.*

22.2.2 Proposals

A substantial part of GRE consists of proposed analytical architectures, taxonomies, research protocols, representational choices, and institutional or methodological designs. Proposals are intellectually substantive without requiring the evidential standing of established descriptive claims. Their principal burden is to state what problem they address, why the proposed organization is useful, which alternatives remain plausible, and what evidence or experience should revise the proposal.

Definition 22.52 (GRE proposal). A *GRE proposal* is a deliberately introduced conceptual, methodological, formal, classificatory, institutional, or research-programme construction offered for evaluation and possible use rather than presented as an established description of the world.

Examples include proposed distinctions among value forms, a research protocol for tracing conversion interfaces, a taxonomy of power, a category-theoretic representation, or an institutional design principle. The proposal status allows such structures to guide inquiry while protecting the programme from confusing usefulness with discovery.

Definition 22.53 (Proposal rationale). A *proposal rationale* is the stated problem, intended analytical function, comparative advantage, assumptions, and foreseeable limitations that justify introducing a proposed GRE construction.

Proposition 22.54 (Proposal transparency condition). A *GRE proposal* should identify the problem it is designed to address and the considerations that would favor modification, replacement, or abandonment of the proposed construction.

Proposals can acquire stronger status over time. A classificatory proposal can become empirically useful across multiple domains; a measurement proposal can accumulate validation evidence; a formal architecture can repeatedly generate successful predictions or discriminating explanations. The research programme should record such transitions rather than silently retaining the original label.

Definition 22.55 (Proposal maturation). *Proposal maturation* is the process through which a proposed construction acquires additional theoretical, empirical, historical, interpretive, or practical support sufficient to justify a stronger or more differentiated status.

Proposal maturation is not automatic. A widely reused concept can remain a proposal if reuse reflects convenience rather than validation. Conversely, repeated failure can justify narrowing or retirement even when the concept remains rhetorically attractive.

22.2.3 Hypotheses

Hypotheses connect GRE to discriminating inquiry. They state provisional relations, mechanisms, tendencies, or conditions whose support can be strengthened, differentiated, weakened, or rejected through evidence or analysis. Their value lies partly in making the framework vulnerable to informative failure.

Definition 22.56 (GRE hypothesis). A *GRE hypothesis* is a provisional proposition about a relation, mechanism, pattern, condition, or consequence that yields discriminating implications for empirical, historical, comparative, formal, or interpretive investigation.

The hypothesis category should remain narrower than speculation. A statement becomes a useful research hypothesis when the programme can identify observations, reconstructions, comparisons, or formal consequences that would alter confidence in it. Some hypotheses may be probabilistic or mechanism-oriented rather than reducible to a single statistical test.

Definition 22.57 (Discrimination condition). The *discrimination condition* is satisfied when a hypothesis specifies at least one class of findings capable of differentiating its support from a relevant alternative, boundary case, or null account.

Proposition 22.58 (Hypothesis accountability condition). A *GRE hypothesis* should state its domain, relevant mechanism or relation, expected evidential implications, and material alternatives with enough precision that later findings can change its status.

This requirement is compatible with exploratory research. Early work may initially identify a family of hypotheses whose distinctions become sharper as evidence accumulates. The important discipline is to preserve the transition from exploratory possibility to testable proposition rather than retrospectively presenting exploratory language as though it had predicted the result.

Definition 22.59 (Hypothesis family). A *hypothesis family* is a set of related provi-

sional explanations that share a research object while differing in mechanism, scale, temporal structure, or boundary conditions and therefore permit discriminating comparison.

Hypothesis families are especially appropriate for GRE because relational phenomena often admit multiple plausible pathways. Declining generative return, for example, might arise through institutional capture, capacity erosion, conversion loss, delayed feedback, or power over access. Treating these as a family preserves alternative mechanisms long enough for research to discriminate among them.

Proposition 22.60 (Hypothesis differentiation condition). *Where multiple GRE mechanisms can generate similar manifestations, the research programme should preserve them as differentiated hypotheses until evidence or analysis supports stronger identification.*

22.2.4 Illustrative Constructions

GRE frequently uses examples, schematic diagrams, toy models, thought experiments, stylized histories, and formal analogies to clarify concepts or expose possible mechanisms. Such constructions can be analytically valuable while carrying little or no direct evidential weight. Their status should therefore remain explicit.

Definition 22.61 (Illustrative construction). An *illustrative construction* is an example, schematic model, diagram, analogy, toy case, or thought experiment introduced primarily to clarify a distinction, demonstrate a possible relation, or explore the consequences of assumptions rather than to report an empirically established finding.

Definition 22.62 (Illustrative adequacy). *Illustrative adequacy* is the degree to which an illustrative construction clarifies its intended analytical object without introducing misleading implications about empirical frequency, causal identification, ontological status, or normative priority.

An illustration can fail even when logically coherent. A toy model may make one mechanism visible by suppressing institutional conditions that are indispensable in real settings. A diagram may imply symmetry where power is asymmetric. A hypothetical example may be memorable enough that readers infer empirical typicality. Illustrative status therefore requires explicit control of what the construction is permitted to show.

Proposition 22.63 (Illustration non-entailment condition). *The successful illustration of a GRE mechanism establishes its intelligibility or possibility under the construction's assumptions; additional evidence is required before inferring empirical prevalence, causal importance, or normative significance.*

Formal analogies require the same restraint. A field representation, network, category-theoretic diagram, operator algebra, or spacetime construction can clarify relations among variables or events without establishing that the economic object possesses the ontology associated with the mathematical formalism.

Definition 22.64 (Illustration-to-hypothesis transition). An *illustration-to-hypothesis transition* occurs when an illustrative construction is supplemented with sufficiently explicit domain conditions and discriminating implications to support empirical, historical, comparative, formal, or interpretive testing.

Recording this transition protects the research programme against status drift. A schematic idea can mature into a hypothesis, but the stronger status should arise

through additional specification rather than repetition.

22.2.5 Domain-Specific Claims

Many economically meaningful GRE claims are expected to hold only within bounded domains. Institutions, legal categories, technologies, ecosystems, cultures, organizational forms, and historical periods can alter the meaning and operation of apparently similar relations. Domain-specific status therefore records a boundary of warrant rather than a weakness to be hidden.

Definition 22.65 (Domain-specific GRE claim). A *domain-specific GRE claim* is a claim whose warranted interpretation or support is restricted to a specified population, institution, jurisdiction, technology, historical period, ecological setting, organizational form, scale, or other materially relevant domain.

Definition 22.66 (Domain envelope). A *domain envelope* is the set of contextual conditions within which a domain-specific claim has been established, proposed, or hypothesized and beyond which transfer requires additional justification.

Domain specificity matters particularly when GRE uses common relational language across heterogeneous fields. A conversion interface in a platform economy and a conversion interface in care provision may share an abstract form while differing in rights, coercion, embodiment, temporality, and value grammar. The common representation can support comparison without licensing unrestricted transfer.

Proposition 22.67 (Domain-transfer condition). A *GRE claim should be transferred beyond its domain envelope only when the research programme establishes that the mechanism, meaning, measurement, and relevant boundary conditions remain sufficiently preserved in the target domain.*

Definition 22.68 (Domain contraction). *Domain contraction* is the revision of a GRE claim to a narrower domain after evidence or analysis shows that its previous scope exceeded the conditions under which the claim remains adequately supported.

Domain contraction is a form of progress when it increases correspondence between the claim and its support. The open programme should therefore record narrowing alongside successful extension.

Proposition 22.69 (Domain-specific strength condition). *A well-supported domain-specific claim can carry stronger warranted force within its domain envelope than a broader claim supported only by analogy or weak transfer evidence.*

22.2.6 Open Claims

GRE contains questions and provisional conceptual possibilities that remain intentionally unresolved. The open status prevents incomplete work from acquiring apparent authority merely through inclusion in a large framework. It also gives the research programme a way to preserve uncertainty as a structured object of inquiry.

Definition 22.70 (Open GRE claim). An *open GRE claim* is a proposition, conjecture, mechanism, distinction, or research direction whose present support is insufficient for stronger status and whose uncertainty is retained explicitly as part of the programme.

Definition 22.71 (Open problem record). An *open problem record* is a versioned statement of an unresolved question together with its motivation, known constraints, rele-

vant evidence, competing possibilities, dependencies, and conditions that would permit meaningful progress.

The open category is broader than hypothesis because some problems are not yet sufficiently specified to produce discriminating implications. A newly identified phenomenon may require conceptual clarification before hypothesis formation. A normative conflict may require interpretation of affected-party values before evaluation criteria can be formulated. A formal analogy may require more primitive definitions before it becomes a model.

Proposition 22.72 (Open-status discipline). *An unresolved GRE object should retain open status until the programme can state a stronger warrant for proposal, hypothesis, domain-specific claim, established argument, or another differentiated status.*

Open status should not become a permanent holding category. Some questions become unproductive, unanswerable with available access, or redundant after conceptual revision. The programme should be able to suspend or retire them while preserving the reason for doing so.

Definition 22.73 (Open-claim retirement). *Open-claim retirement* is the documented removal of an open claim or problem from active inquiry because it has been resolved, absorbed into another question, rendered incoherent by revision, blocked by persistent access limitations, or judged to have insufficient research value relative to available alternatives.

22.2.7 Contested Claims

Some GRE claims will remain contested even after substantial evidence and argument. Contestation can concern the interpretation of evidence, choice of explanatory object, normative criterion, historical reconstruction, causal mechanism, formal representation, or disciplinary boundary. The research programme should represent such disagreement rather than converting one position into silent framework default.

Definition 22.74 (Contested GRE claim). A *contested GRE claim* is a claim for which materially relevant alternatives retain sufficient theoretical, empirical, historical, interpretive, methodological, or normative warrant that disagreement should remain explicit in the programme state.

Definition 22.75 (Contestation record). A *contestation record* is an account of the competing positions, their principal warrants, the dimensions on which they disagree, the evidence capable of discriminating among them where such evidence is available, and any remainder expected to persist after empirical comparison.

Contestation differs from weak support. Two positions may each be sophisticated and well supported while relying on incompatible normative commitments or distinct explanatory priorities. Chapter 21 developed irreducible theoretical disagreement for precisely this reason. The status architecture carries that discipline into the research programme.

Proposition 22.76 (Contestation preservation condition). *Where competing claims retain material warrant, GRE should preserve the disagreement in downstream research until an explicit adjudication, scope differentiation, or plural explanatory architecture justifies changing its status.*

Definition 22.77 (Contestation localization). *Contestation localization* is the identification of the specific ontological, epistemic, causal, methodological, historical, norma-

tive, or value-related dimension on which competing claims remain in conflict.

Localization reduces false disagreement. Two studies may appear contradictory while addressing different scales, periods, populations, or meanings of the same term. Conversely, apparent agreement may conceal different normative or ontological commitments. Claim status should therefore record the location of contestation, not merely a binary contested/uncontested flag.

Proposition 22.78 (Localized-contestation revision condition). *A contested claim should change status only in relation to the dimensions for which the programme has generated materially stronger warrant, leaving unresolved dimensions explicitly open where appropriate.*

22.2.8 Revision-Dependent Claims

The final status concerns claims whose present admissibility depends materially on upstream elements that remain likely to change. Revision dependence is common in an open framework because later chapters can rely on early taxonomies, formal choices, measurement assumptions, or domain interpretations that subsequent research may revise.

Definition 22.79 (Revision-dependent GRE claim). *A revision-dependent GRE claim is a claim whose present warrant relies materially on one or more upstream claims, definitions, measurements, representations, or assumptions whose revision would require reevaluation of the dependent claim.*

Definition 22.80 (Revision trigger). *A revision trigger is an evidential, theoretical, formal, historical, interpretive, normative, or domain-specific development specified in advance as sufficient to require reevaluation of a claim or its status.*

Revision triggers make openness operational. A power taxonomy may require revision if repeated empirical studies reveal a recurring mechanism outside its categories. A value-conversion model may require revision if the assumed conversion interface proves historically unstable. A measurement claim may require revision if interpretive work shows that the indicator changes meaning across institutions.

Definition 22.81 (Status transition). *A status transition is a documented change in the epistemic classification of a claim, including the evidence or argument motivating the change and the consequences for dependent claims.*

Status transitions can move in several directions. A proposal can mature into an established analytical protocol; a hypothesis can be narrowed to a domain-specific claim; an established argument can become contested after new evidence; an open problem can be retired; an illustrative construction can become a formal model; a broad claim can contract. The architecture should preserve these histories because the path of revision can itself reveal where the framework was previously overconfident or underspecified.

Definition 22.82 (Claim-status ledger). *A claim-status ledger is a versioned record linking GRE claims to their current status, status provenance, domain envelope, dependencies, revision triggers, contestation state, and status-transition history.*

Proposition 22.83 (Status-ledger condition). *Claims that materially organize GRE theory, measurement, formalization, comparison, or intervention should be represented in a claim-status ledger with enough provenance and dependency information to support later revision propagation.*

Proposition 22.84 (Epistemic non-escalation condition). *Repetition, formal sophistication, centrality within the framework, or practical usefulness should not by themselves increase the epistemic status of a GRE claim; stronger status requires stronger or more appropriate warrant.*

This final condition is central to programme governance. A claim can become architecturally important before it becomes empirically secure. A formal object can become elegant without becoming better identified. A concept can become widely reused while retaining uncertain boundaries. The status architecture prevents cumulative visibility from being mistaken for cumulative warrant.

Section 22.1 established where GRE research occurs and how its methodological layers communicate. The present section establishes what epistemic force individual programme claims may carry at a given version of the framework. The next research stream can therefore begin from a differentiated claim base. Section 501 turns to relational economic architecture and asks how entities, relations, institutions, organizations, fields, scales, and historical transformations can be investigated without losing the status discipline established here.

22.3 Research on Relational Economic Architecture

The role of this section is to convert the relational architecture developed in the earlier economic-architecture analysis into a research programme with identifiable objects, evidential burdens, comparison procedures, and revision conditions. Its objective is to specify how researchers can investigate the formation and persistence of economic entities, reconstruct relational configurations, identify institutional and organizational stabilization, study field-level conditions, connect processes across scales, trace historical transformation, and compare alternative architectures. The discussion proceeds through eight corresponding research domains. The method is programmatic and methodologically plural: historical, interpretive, qualitative, quantitative, formal, computational, legal, organizational, and comparative strategies can each contribute where their evidential access is appropriate to the local object.

Relational economic architecture should become empirically researchable without being reduced to a single representation such as a network, hierarchy, organization chart, institutional rule set, or matrix of transactions. The earlier economic-architecture analysis treated economic architecture as a configuration of subjects, entities, relations, institutions, boundaries, resources, capacities, constraints, access conditions, ownership structures, infrastructures, and fields whose organization can be economically consequential. A research programme therefore requires procedures for deciding which of these elements belong to a particular inquiry, how their presence is warranted, how their historical continuity is reconstructed, and which omissions would materially change explanation or evaluation.

Definition 22.85 (Relational-architecture research object). *A relational-architecture research object is a provisionally bounded economic configuration whose entities, relations, institutional structures, organizational condensations, field conditions, scales, and historical transformations are specified because their organization is materially relevant to the research question.*

Definition 22.86 (Architectural evidential burden). *An architectural evidential burden is the set of observations, records, interpretations, measurements, formal con-*

straints, or comparative evidence required to warrant the inclusion, characterization, continuity, or transformation of a component within a relational-architecture claim.

Proposition 22.87 (Architectural research adequacy). *A study of relational economic architecture is adequate to its stated purpose only where the architecture represented is sufficiently rich to preserve the mechanisms relevant to the claim and sufficiently bounded to permit evidential discrimination among plausible alternatives.*

The adequacy condition places symmetrical pressure on overexpansion and oversimplification. A representation that includes every conceivable relation can become empirically unmanageable and weakly discriminating. A representation that retains only readily measurable relations can exclude precisely the institutional, historical, or interpretive structures that organize the process of interest. Research design therefore requires an explicit relation between the claim being investigated and the architecture needed to support or revise it.

Table 22.3 summarizes the eight research domains developed in this section and the principal evidential burden associated with each.

22.3.1 Entity Formation

Research on entity formation examines how a configuration becomes sufficiently differentiated, stabilized, recognized, and historically trackable to function as an economic entity for a specified inquiry. The earlier conceptual definition of economic entityhood makes entityhood relative to continuity criteria, boundaries, scale, and evidential purpose. The research programme must therefore identify the mechanisms through which entity attribution becomes empirically warranted and the conditions under which that attribution should be revised.

Entity formation can involve legal constitution, contractual linkage, repeated coordination, material assembly, accounting separation, technical integration, common dependence, membership practice, or public recognition. These mechanisms can reinforce one another while remaining analytically distinct. A corporation, household, project consortium, platform ecosystem, infrastructure system, informal enterprise, research collaboration, or commons may therefore acquire entity-like stability through different combinations of mechanisms.

Definition 22.88 (Entity-formation mechanism). An *entity-formation mechanism* is an empirically identifiable process through which a configuration becomes more differentiated, reproducible, recognized, governable, or historically trackable as a unit for the economic mechanism under study.

Definition 22.89 (Entity-attribution protocol). An *entity-attribution protocol* records the proposed entity, the continuity criteria used to identify it, the boundary and scale of analysis, the mechanisms supporting stabilization, the evidence for those mechanisms, plausible competing entity specifications, and the conditions under which the attribution should be revised.

This protocol helps address a recurring identification problem. Administrative and commercial datasets often begin with predefined units such as firms, households, accounts, municipalities, or registered organizations. Those units can be appropriate, but their availability does not establish that they are the analytically relevant entities for every question. A supply network may cut across firm boundaries; a household may contain economically consequential internal divisions; a platform ecosystem

Table 22.3: Principal research domains in relational economic architecture

Research domain	Primary object	Characteristic evidence	Principal research burden
Entity formation	Stabilized economic units and continuity criteria	Legal, organizational, accounting, technical, material, and participant records	Distinguish formation, recognition, persistence, and reification
Relational configurations	Patterned arrangements among heterogeneous relations	Relational records, interviews, archives, transactions, network and higher-order data	Preserve configuration-level dependence beyond isolated dyads
Institutional structures	Rules, classifications, authority, enforcement, and recurrent practices	Law, policy, administrative records, routines, implementation evidence	Separate formal specification from enacted institutional operation
Organizational condensation	Concentrated coordination, roles, resources, memory, and authority	Governance records, workflows, membership, budgets, routines, internal communication	Identify mechanisms sustaining organizational coherence and boundary change
Relational fields	Distributed conditions shaping positions and interaction	Market, spatial, regulatory, network, platform, cultural, and infrastructural evidence	Identify field exposure and influence without reifying the field
Multiscale architecture	Coupled configurations operating at distinct analytical scales	Linked micro, meso, macro, spatial, temporal, and institutional data	Establish cross-scale mechanisms and aggregation limits
Historical transformation	Formation, reproduction, reorganization, rupture, and residual structure	Longitudinal data, archives, institutional histories, event sequences, oral histories	Reconstruct continuity and change with mechanism-specific periodization
Comparative architectures	Differences and commonalities across cases or configurations	Harmonized case materials, relational indicators, historical and institutional comparison	Compare architectures without forcing premature commensurability

may include nominally independent firms whose practical options are conditioned by common technical and governance infrastructure.

Proposition 22.90 (Entity-reification control). *Where the empirical unit supplied by a dataset, legal category, or institutional practice materially shapes the result, research on relational economic architecture should test whether the unit’s attributed continuity*

and boundary are supported by the mechanism under investigation.

Entity formation is also temporally extended. Researchers can study founding events, gradual stabilization, recognition thresholds, boundary consolidation, succession, fragmentation, merger, and dissolution. Longitudinal work can examine whether entity continuity depends on persistent membership, role structure, legal identity, material assets, technical interfaces, institutional recognition, or an event history linking successive states.

Definition 22.91 (Entity-continuity evidence). *Entity-continuity evidence* is evidence that supports treating temporally separated states as belonging to one historically continuous economic entity relative to a specified continuity criterion.

Proposition 22.92 (Plural continuity test). *Where several continuity criteria are economically plausible, entity research gains explanatory precision by reporting which criteria converge, which diverge, and which one the substantive claim requires.*

A major empirical programme follows from this plurality. Researchers can compare legal, accounting, organizational, participant-defined, technological, and relational boundaries of the same apparent entity. Divergence among those boundaries can itself become explanatory, especially where responsibilities, risks, benefits, control, or dependencies cross the boundary recognized by one institutional system.

22.3.2 Relational Configurations

Research on relational configurations examines patterned arrangements in which several entities and relations jointly contribute to an economic mechanism. The research burden extends beyond identifying individual ties. It concerns how relation types coexist, depend on one another, form chains or cycles, create higher-order relations, stabilize positions, and produce configuration-level consequences.

Definition 22.93 (Empirical relational configuration). An *empirical relational configuration* is a warranted representation of multiple economically relevant entities, relations, positions, or higher-order dependencies whose joint arrangement carries explanatory or evaluative significance for a stated research question.

A configuration can include contractual, financial, care, labor, informational, ownership, authority, infrastructural, ecological, reputational, or recognition relations. These relations need not share one data-generating process. Research can therefore require integration across administrative data, interviews, legal records, digital traces, transaction records, ethnography, archives, spatial data, or organizational documents. The challenge is to preserve provenance while combining evidence that observes different manifestations of the same configuration.

Definition 22.94 (Configuration provenance map). A *configuration provenance map* records, for each represented entity, relation, position, or higher-order dependency, the evidential source, temporal coverage, inferential status, uncertainty, and transformation through which it entered the reconstructed configuration.

Configuration research should also distinguish observed absence from unobserved relation. An apparent gap can result from genuine nonrelation, missing data, inaccessible records, incompatible identifiers, informal practice, strategic concealment, or a relation type that the measurement system does not encode. The methodological analysis developed these epistemic problems earlier in the book; the present chapter makes them part of the substantive research programme.

Proposition 22.95 (Configuration-missingness condition). *A configuration-level claim should treat materially uncertain relation absence as an inferential problem where plausible missingness mechanisms could alter the configuration or the mechanism attributed to it.*

The research programme also includes higher-order organization. A rule can authorize a relation; a guarantee can support a credit relation; a platform standard can condition several market relations; an institutional classification can determine eligibility for multiple services; a governance procedure can determine how contractual relations are revised. Pairwise edge representations can remain useful, but configuration research should introduce higher-order representations where relational dependence itself is part of the claim.

Definition 22.96 (Configuration-level mechanism). *A configuration-level mechanism is a process whose operation depends materially on the arrangement, interaction, or higher-order dependence among several relations rather than on the properties of one isolated relation alone.*

Proposition 22.97 (Configuration representation adequacy). *A relational representation is adequate for a configuration-level claim only where it preserves the dependencies required by the proposed mechanism at the resolution relevant to the inquiry.*

This proposition creates a comparative formal research agenda. Networks, multilayer networks, hypergraphs, event structures, relational databases, agent-based models, category-theoretic representations, or qualitative configuration maps can be evaluated by what each preserves and obscures. The choice among them should depend on the research object rather than on formal novelty.

22.3.3 Institutional Structures

Institutional research examines the recurrent rules, classifications, authority relations, procedures, expectations, enforcement practices, and interpretive conventions through which economic relations become organized and reproduced. The research programme gives particular attention to the difference between formally specified institutions and institutions as enacted within concrete relational fields.

Definition 22.98 (Institutional-structure specification). *An institutional-structure specification identifies the rules, classifications, offices, decision procedures, enforcement arrangements, recognized statuses, implementation practices, and interpretive conventions that materially condition the economic relations under study.*

Formal sources can identify legal rights, eligibility criteria, administrative procedures, corporate rules, standards, or contractual terms. Enacted operation can differ because interpretation, discretion, organizational capacity, informal routines, professional norms, technical interfaces, resource scarcity, or participant strategies affect how the institution becomes manifest in practice. Research therefore benefits from linking formal institutional analysis with implementation evidence.

Definition 22.99 (Institutional enactment gap). *An institutional enactment gap is a materially relevant difference between an institution's formally specified rule or position and the recurrent practices, access conditions, decisions, or consequences through which that rule or position is realized.*

Proposition 22.100 (Institutional dual-evidence condition). *Where a claim concerns the practical economic consequences of an institution, evidence of formal specification*

gains explanatory adequacy when combined with evidence about implementation, interpretation, access, enforcement, and affected positions.

Institutional structures also generate categories through which economic actors become legible. Employment status, household status, ownership, disability classification, residency, professional qualification, firm size, sector, beneficiary category, or platform-user type can alter rights, obligations, data visibility, and access. These classifications are therefore research objects when their construction changes the architecture under study.

Definition 22.101 (Institutional classification effect). An *institutional classification effect* is a change in economic position, access, obligation, visibility, resource flow, or feasible action that occurs because an actor or configuration is assigned to, excluded from, or moved between institutionally operative categories.

Institutional research should also study change. Rules can be amended while practices remain stable; administrative interpretation can change while formal law remains constant; technical standards can alter access before statutory reform; informal institutions can persist after official replacement. This creates an empirical programme on institutional lag, anticipatory adaptation, implementation sequencing, and differential transition across positions.

Proposition 22.102 (Institutional-change decomposition). *Research on institutional transformation gains precision by distinguishing change in formal specification, interpretation, implementation capacity, enforcement, classification, participant response, and downstream relational consequence.*

22.3.4 Organizational Condensation

Organizations were developed earlier in the book as relational condensations: comparatively stabilized concentrations of roles, resources, authority, routines, memory, boundaries, and coordination. The research programme investigates which mechanisms produce this condensation, how strong and durable it becomes, and how organizational coherence changes when membership, authority, technology, resources, or external dependencies change.

Definition 22.103 (Condensation profile). An *organizational-condensation profile* records the degree and mechanisms through which roles, decision authority, resource control, routines, memory, membership, communication, and boundary maintenance become concentrated and recurrent within an organizational configuration.

The profile supports comparison without assuming one universal organizational form. A ministry, corporation, cooperative, laboratory, hospital, neighborhood association, open-source project, humanitarian organization, platform operator, and informal enterprise can display different combinations of condensation. Formal hierarchy may be strong while membership is fluid; technical coordination may be strong while legal identity is weak; shared memory may persist after substantial turnover.

Definition 22.104 (Organizational coherence mechanism). An *organizational coherence mechanism* is a process through which differentiated participants, roles, resources, routines, or infrastructures remain sufficiently coordinated for an organization to reproduce selected functions or identities across events.

Proposition 22.105 (Organizational mechanism plurality). *Organizational continuity*

should be attributed to the mechanisms that reproduce the relevant coordination and identity dimensions, because similar observable continuity can arise through different combinations of hierarchy, routine, infrastructure, membership practice, contract, technical integration, or shared memory.

A substantial empirical agenda concerns internal differentiation. Organization-level variables can conceal unequal access to information, authority, voice, resources, security, promotion, or exit. Relational organizational research can therefore map internal positions and the pathways through which organizational decisions distribute consequences across them.

Definition 22.106 (Internal organizational architecture). An *internal organizational architecture* is the patterned arrangement of roles, authority, information, resources, routines, dependencies, and participation pathways through which an organization coordinates activity and distributes practical capacity among internal positions.

Research can then connect internal and external architecture. Supply dependence, regulation, finance, labor markets, professional fields, standards, infrastructure, community relations, and platform rules can condition organizational options. Organizational boundaries therefore become empirical interfaces rather than assumptions that external effects begin only after activity crosses a fixed line.

Proposition 22.107 (Organizational-boundary interface condition). *Where external relations materially reproduce internal organizational capacity or internal decisions materially reorganize external relations, research should treat the organizational boundary as an interface whose permeability and governance require empirical specification.*

22.3.5 Relational Fields

Research on relational fields examines distributed conditions that shape positions and interactions across a domain without requiring those conditions to be reducible to isolated pairwise relations. Market access, regulatory intensity, infrastructural quality, land values, information environments, professional expectations, platform visibility, ecological exposure, credit conditions, or institutional recognition can vary across positions and thereby alter feasible action.

Definition 22.108 (Empirical relational field). An *empirical relational field* is a bounded representation of distributed relational conditions whose variation across positions materially shapes interaction, access, constraint, exposure, expectation, or capability within the domain and period under study.

Field language requires particular empirical discipline because it can easily become a metaphor for diffuse influence. A researchable field claim should identify what varies, across which positions or locations, through which mechanism, over what interval, and with what observable consequences. Spatial, network, institutional, market, organizational, or computational representations may each be appropriate depending on the field mechanism.

Definition 22.109 (Field-exposure measure). A *field-exposure measure* is an empirical indicator or structured qualitative assessment of the degree to which a position is subject to, benefits from, or can influence a specified field condition during a stated period.

Proposition 22.110 (Field-specification burden). *A field-based explanation gains em-*

pirical standing only where the field variable, mechanism of exposure or influence, relevant boundary, temporal resolution, and plausible alternative explanations are sufficiently specified for the claim being made.

Field research can also examine feedback. Participants may alter the conditions to which they are exposed through collective action, investment, standard setting, market entry, political influence, infrastructure creation, platform governance, or cultural change. A field is therefore potentially endogenous to the actions it conditions.

Definition 22.111 (Field feedback). *Field feedback* is a process in which actors or configurations affected by a distributed relational condition materially alter the later state, distribution, or governance of that condition.

Proposition 22.112 (Reflexive field condition). *Where field feedback is materially strong, research should model or reconstruct the field and participant responses as a coupled process rather than treating the field exclusively as an exogenous environment.*

This agenda is especially relevant for markets and platforms, where prices, rankings, standards, participation, reputation, liquidity, and expectations can be jointly generated through interaction. It is also relevant for public institutions and spatial economies where policy, infrastructure, and participant adaptation recursively alter exposure patterns.

22.3.6 Multiscale Architecture

Economic architecture is frequently organized across several scales at once. Individual choices can depend on household relations; household possibilities can depend on organizations and public institutions; organizations can depend on sectoral standards, financial systems, infrastructures, and transnational arrangements. The research programme therefore requires explicit procedures for linking scales while avoiding assumptions that patterns at one scale automatically reproduce at another.

Definition 22.113 (Architectural scale). An *architectural scale* is a stated analytical resolution at which particular entities, relations, configurations, or field conditions are treated as relevant units for a research claim.

Definition 22.114 (Cross-scale coupling). A *cross-scale coupling* is a mechanism through which a process represented at one analytical scale materially changes, constrains, enables, aggregates into, or is conditioned by a process represented at another scale.

Cross-scale research should identify the mechanism rather than infer coupling from correlation between aggregate and local patterns. Institutional rules can change household behavior through eligibility and enforcement; household care structures can alter labor supply and organizational participation; organizational adoption can transform sectoral standards; local ecological degradation can aggregate into regional constraints; macroeconomic instability can propagate through credit and employment relations.

Proposition 22.115 (Cross-scale mechanism condition). *An inference across architectural scales should identify the pathway through which change at one scale becomes consequential at another and should state the aggregation, mediation, or feedback assumptions required by that inference.*

Aggregation itself becomes a research object. Aggregate stability can coexist with

substantial relational turnover, while local stability can coexist with systemic transformation. Averages can conceal polarization, bottlenecks, concentration, segregation, or unequal exposure. Conversely, highly variable local events may cancel at a higher scale.

Definition 22.116 (Aggregation remainder). An *aggregation remainder* is information about relational organization, heterogeneity, dependence, or distribution that is materially relevant to a claim but is lost when lower-scale configurations are represented by an aggregate quantity or category.

Proposition 22.117 (Multiscale reporting condition). *Where an aggregation remainder could materially alter explanation, evaluation, or intervention design, multiscale research should report both the aggregate pattern and the lower-scale relational structure responsible for the remainder.*

Formal models can support this work where their scale assumptions are explicit. Hierarchical models, multilayer networks, agent-based models, spatial models, coupled dynamical systems, and event-based representations offer different ways to connect scales. Their adequacy depends on whether the chosen representation preserves the mechanism and uncertainty relevant to the question.

22.3.7 Historical Transformation

Research on historical transformation investigates how relational economic architectures form, reproduce, reorganize, fragment, dissolve, and leave residual structures that condition later arrangements. The programme builds on the historical and methodological discipline developed in the earlier parts of the book: present architecture is interpreted as a historically generated configuration whose relevant temporal depth depends on the mechanism under study.

Definition 22.118 (Architectural transformation sequence). An *architectural transformation sequence* is an evidentially reconstructed ordering of events, relational changes, institutional modifications, boundary shifts, and field changes through which an economic architecture acquires a materially different operating configuration.

The principal research challenge is continuity attribution. A legal form can remain stable while practical coordination changes; an organization can retain its name while authority and technology are reorganized; a market can retain participants while intermediaries and standards change; a public institution can change implementation without legislative revision. Periodization should therefore be tied to the relation or mechanism under analysis.

Definition 22.119 (Mechanism-relative periodization). *Mechanism-relative periodization* partitions a historical sequence according to changes in the relations, institutions, capacities, constraints, or field conditions that are causally or interpretively relevant to the specified mechanism.

Proposition 22.120 (Historical continuity test). *A claim of architectural persistence across periods should identify which dimensions remain continuous, which change, and why the preserved dimensions are sufficient for the historical identity required by the research question.*

Historical transformation also produces residual architecture. Debt, infrastructure, legal obligations, data, standards, reputations, environmental effects, learned

routines, spatial patterns, and institutional memories can survive the configuration that generated them. These residues can become formation conditions for later entities and relations.

Definition 22.121 (Architectural residue). An *architectural residue* is a relation, obligation, capacity, constraint, material structure, classification, expectation, memory, or environmental consequence generated by an earlier architecture that remains economically consequential after that architecture has materially changed or dissolved.

Proposition 22.122 (Residual-history condition). *Historical explanation should include architectural residues where their omission would make a later configuration appear more self-generated, reversible, or institutionally unconstrained than the evidence supports.*

This creates a programme for longitudinal and archival reconstruction alongside quantitative panel analysis, sequence analysis, oral history, legal history, institutional genealogy, and historical simulation. Different methods can reconstruct different parts of the transformation sequence, and disagreement among them can reveal uncertainty rather than merely methodological failure.

22.3.8 Comparative Architectures

Comparative research examines how relational economic architectures differ across places, periods, sectors, organizations, institutional regimes, technologies, or populations. Its purpose is to identify recurring mechanisms, architecture-specific effects, transfer limits, and alternative configurations that can produce similar or different outcomes. Comparison therefore extends the pluralist discipline developed in the preceding theoretical-dialogue chapter into empirical and historical research design.

Definition 22.123 (Architecture comparison frame). An *architecture comparison frame* specifies the cases, dimensions, scales, periods, evidential bases, and relational mechanisms along which two or more economic architectures are being compared.

The frame is necessary because apparent similarity can depend on coarse description. Two systems can share a legal category while differing in implementation; two organizations can perform similar functions through different authority structures; two markets can display similar prices while differing in concentration, access, or infrastructural dependence. Conversely, architectures that look institutionally different can realize similar functions under specific conditions.

Definition 22.124 (Architecture family). An *architecture family* is a provisional comparative grouping of economic configurations that share a specified set of relational, institutional, organizational, field, or historical characteristics relevant to a research purpose.

Proposition 22.125 (Comparative-family scope condition). *Membership in an architecture family supports inference only with respect to the characteristics used to define that family and does not establish general similarity across omitted dimensions.*

Comparative work also requires attention to transfer. A mechanism established in one architecture may depend on institutional capacities, historical inheritances, social meanings, infrastructural conditions, or field structures that are absent elsewhere. Comparison should therefore identify both shared mechanism components and architecture-specific dependencies.

Definition 22.126 (Architectural transfer condition). An *architectural transfer condi-*

tion is a condition whose presence is required for a mechanism, interpretation, intervention effect, or empirical regularity established in one relational architecture to remain informative in another.

Definition 22.127 (Comparative architecture remainder). A *comparative architecture remainder* is a materially relevant feature of a case that is not captured by the common comparison frame and may limit generalization, equivalence, or policy transfer.

Proposition 22.128 (Comparative remainder condition). *Where a comparative architecture remainder plausibly modifies the mechanism under study, the remainder should remain explicit in the inference rather than being absorbed into unexplained case heterogeneity.*

The resulting research programme treats comparative architecture as a route to both generalization and correction. Repeated mechanisms across heterogeneous architectures can justify more portable hypotheses. Persistent divergence can reveal hidden boundary conditions. Cases that resist the available relational vocabulary can require revision of GRE's categories themselves. Comparative research thereby connects architectural inquiry to the claim-status discipline of Section 22.2: findings can strengthen, narrow, split, contest, or retire architectural claims according to the evidence produced.

Definition 22.129 (Architecture research portfolio). A *relational-architecture research portfolio* is a coordinated set of entity, configuration, institutional, organizational, field, multiscale, historical, and comparative studies designed so that results from one domain can revise object specification, mechanism hypotheses, measurement choices, and transfer conditions in the others.

Proposition 22.130 (Architectural programme closure condition). *Research on relational economic architecture contributes cumulatively to GRE when entity attribution, configuration reconstruction, institutional and organizational mechanisms, field conditions, scale relations, historical transformation, and comparative transfer are recorded with sufficient provenance that later evidence can revise both local findings and the architecture used to produce them.*

The closure condition is provisional in the programme sense established in Section 22.1. It closes the present section by making its objects and revision pathways explicit while leaving the substantive research open. The next section narrows the programme to relational allocation, where architecture becomes consequential through the assignment of resources, rights, burdens, access positions, and infrastructures and through the downstream relations generated by those assignments.

22.4 Research on Relational Allocation

The role of this section is to convert the earlier GRE account of relational allocation into a research programme with explicit objects, evidential burdens, comparison procedures, and revision conditions. Its objective is to specify how allocation can be investigated at entity, relation, and higher-order levels while preserving the distinction between nominal receipt and effective incidence. The discussion proceeds through entity-level allocation, relation-indexed allocation, higher-order allocation, enabling conditions, relational consequences, long-horizon effects, allocation under asymmetry, and comparative evaluation. The method is programmatic and

methodologically plural: administrative data, household and organizational inquiry, relational statistics, historical reconstruction, institutional analysis, qualitative and participatory methods, causal designs, formal models, and simulation can contribute where they address the mechanism and time horizon relevant to the allocation claim.

Relational allocation research begins from a familiar economic fact: resources, rights, services, responsibilities, authority, access, infrastructure, and opportunities are commonly assigned through identifiable rules and recipients. GRE adds a second analytical question. An allocation can alter the relations, conversion conditions, collective capacities, dependencies, institutional positions, and future options through which its economic significance is realized. The research task is therefore to reconstruct the architecture of incidence without presuming that the administrative recipient, the effective beneficiary, the bearer of burdens, and the locus of later consequence coincide.

Definition 22.131 (Relational-allocation research object). *A relational-allocation research object is a provisionally bounded allocation episode, rule, programme, institution, or recurring process whose allocated objects, recipients, relational incidence, enabling conditions, higher-order effects, asymmetries, and temporal consequences are specified because they are materially relevant to the research question.*

Definition 22.132 (Allocation-incidence architecture). *An allocation-incidence architecture is the structured account of where an allocation is formally assigned, where it becomes effectively usable, how it is redistributed or mediated, which relations and configurations it changes, and where benefits, burdens, risks, control, and later consequences are realized.*

Proposition 22.133 (Allocation research traceability). *A relational allocation claim is researchable when the study can identify the allocated object, allocation rule or event, relevant recipient boundary, principal conversion and transmission mechanisms, and the evidential basis for attributing consequences beyond nominal receipt.*

Table 22.4 summarizes the principal research domains developed in this section. The table is a design aid rather than a universal checklist. A study can remain comparatively simple when the selected allocation boundary captures the mechanisms material to the claim.

22.4.1 Entity-Level Allocation

Entity-level allocation research studies allocations whose primary recorded recipient is an identifiable person, household, organization, public body, firm, community organization, or other recognized economic unit. The research objective is to preserve the tractability of recipient-level records while testing when the selected entity boundary adequately represents effective incidence. This makes entity-level allocation an empirical starting point rather than a presumption that the consequences of receipt remain inside the recipient.

Definition 22.134 (Allocation-object profile). *An allocation-object profile specifies what is allocated, including its quantity or extent where meaningful, legal and institutional form, divisibility, duration, conditions of use, transferability, control rights, obligations, and relevant complementarities.*

The allocated object matters because nominally similar transfers can represent materially different economic positions. Cash, a license, access to a database, a care

Table 22.4: Principal research domains in relational allocation

Research domain	Principal object	Selected evidential burden
Entity level	Recipient, allocated position, internal use	Administrative receipt, access, control, internal distribution, conversion
Relation indexed	Formation, maintenance, transformation, or exit of a specified relation	Relational mechanism, participant positions, continuity, dependence, joint effects
Higher order	Shared capacity, infrastructure, rule system, or collective configuration	Complementarity, governance, membership, internal access, configuration-level performance
Enabling conditions	Complementary conditions required for effective use	Availability, sequencing, bottlenecks, substitution, heterogeneous conversion
Relational consequences	Changes in bargaining, dependence, trust, coordination, access, or obligation	Transmission pathway, affected positions, mediators, spillovers, attribution
Long horizon	Delayed effects, maintenance burdens, path dependence, future options	Temporal linkage, persistence, option creation or foreclosure, counterfactual history
Asymmetry	Unequal influence over allocation and unequal conversion of receipt	Rule-setting power, procedural access, capture, dependence, differentiated incidence
Comparative evaluation	Alternative allocation architectures	Common comparison frame, plural criteria, uncertainty, distribution, remainders

service, a place in an educational programme, a procurement contract, a legal entitlement, and discretionary authority differ in how they can be used, transferred, withheld, converted, monitored, and reproduced. Research should therefore identify the economically consequential attributes of the object rather than treat its monetary value as a sufficient description where institutional form changes use.

Definition 22.135 (Recipient-boundary specification). A *recipient-boundary specification* identifies the person, household, organization, institutional unit, or other entity treated as the primary recipient and states why that boundary is appropriate to the allocation claim being investigated.

Definition 22.136 (Effective allocation incidence). *Effective allocation incidence* is the realized distribution of access, use, control, benefit, burden, risk, obligation, or capability associated with an allocation after relevant internal distribution and conversion mechanisms have operated.

Entity receipt and effective incidence can diverge for several reasons. Household transfers can be controlled by particular members; organizational grants can be redirected through internal hierarchy; legal entitlements can remain unusable because complementary services are absent; responsibilities can be assigned to a unit whose members bear the practical time or risk burden. These possibilities motivate research on internal allocation rather than justify an assumption that divergence is present in every case.

Proposition 22.137 (Recipient-incidence differentiation). *Where internal control, redistribution, conversion, or burden-sharing can materially change an allocation's consequences, research should distinguish the recorded recipient from the persons or positions through which effective incidence is realized.*

Definition 22.138 (Entity-allocation trace). An *entity-allocation trace* is a temporally ordered record linking an allocation decision or event to recorded receipt, internal control, effective use, redistribution, and selected downstream consequences within and immediately around the recipient entity.

Entity-allocation traces can be assembled from administrative records, transaction data, organizational documents, interviews, diaries, time-use records, ethnography, surveys, or other evidence appropriate to the object. The research design should preserve distinctions among receipt, authorization, access, use, and benefit because those stages can respond differently to the same allocation rule.

Proposition 22.139 (Entity-level sufficiency test). *An entity-level representation is sufficient for a stated research purpose when omitted internal and external relational mechanisms are unlikely to alter the conclusion materially within the specified claim envelope and time horizon.*

This sufficiency test protects the programme from relational overexpansion. Detailed reconstruction is warranted by a research problem, a plausible mechanism, or observed heterogeneity rather than by the framework's capacity to add more relations.

22.4.2 Relation-Indexed Allocation

Relation-indexed allocation research treats a specified relation as the principal analytical object. Administrative transfers can still pass through conventional recipients, while the research question concerns how allocation changes the conditions of formation, maintenance, transformation, substitution, or dissolution of a relation. Examples can include care relations, employment relations, research collaborations, supplier relations, cooperative membership, credit relations, public-service interfaces, or shared maintenance arrangements.

Definition 22.140 (Relation-allocation specification). A *relation-allocation specification* identifies the relation whose condition is under study, the participating positions, the allocated objects or conditions that can affect it, and the mechanism by which allocation is expected to alter relational formation, continuity, transformation, or exit.

Definition 22.141 (Relational support mechanism). A *relational support mechanism* is a process through which an allocated resource, right, infrastructure, capability, time allowance, information channel, or institutional condition changes the feasibility or quality of a specified relation.

Relational support should be investigated neutrally with respect to persistence. Some allocations can appropriately sustain a relation; others can enable exit from an exploitative or burdensome relation, substitute a safer relation, or reduce dependency on a particular counterpart. The empirical object is the changed relational condition together with its consequences for participants.

Definition 22.142 (Relational incidence). *Relational incidence* is the distribution of changes in access, bargaining position, obligation, dependence, reciprocity, coordination capacity, risk, recognition, or exit capacity among positions participating in or

affected by a relation after an allocation.

Proposition 22.143 (Relation-specific attribution). *A claim that an allocation changed a relation requires evidence connecting the allocation to a specified relational mechanism and to an observable or reconstructable change in participant positions, interaction conditions, or relational continuity.*

Relation-indexed research can use network data, repeated interaction records, contracts, communication traces, qualitative accounts, legal documents, process tracing, or field observation. The method should follow the relational feature at issue. A bargaining claim may require evidence on alternatives and authority; a trust claim may require repeated behavior and interpretive evidence; a coordination claim may require joint performance or interaction data.

Definition 22.144 (Relational baseline). *A relational baseline is the empirically reconstructed condition of the focal relation before or in the absence of the allocation, including participant positions, relevant dependencies, available alternatives, and institutional constraints needed for comparison.*

Proposition 22.145 (Relational allocation comparison). *Where feasible, relation-indexed research should compare post-allocation relational conditions with an explicit historical, contemporaneous, simulated, or otherwise warranted baseline rather than infer relational improvement from resource receipt alone.*

22.4.3 Higher-Order Allocation

Higher-order allocation research concerns shared capacities and configurations whose relevant economic properties depend on coordinated relations among multiple participants. Common infrastructure, interoperable standards, pooled insurance, shared laboratories, commons governance, public information systems, cooperative platforms, and multilateral facilities can create capabilities that are poorly represented by summing individual receipts. The research problem is to identify when configuration-level structure contributes explanatory content and how internal access and governance distribute that shared capacity.

Definition 22.146 (Higher-order allocation object). *A higher-order allocation object is a shared resource, institutional arrangement, infrastructure, rule system, or collective capacity whose economically relevant properties depend materially on coordination, complementarity, membership, or configuration-level organization among multiple positions.*

Definition 22.147 (Collective conversion condition). *A collective conversion condition is a governance, maintenance, coordination, interoperability, contribution, or access condition required for a higher-order allocation to become an effective shared capacity.*

A shared object can exist physically or legally while remaining weakly usable. Infrastructure can lack maintenance; a common database can lack interoperable standards; a cooperative fund can be inaccessible to marginal members; a shared facility can be monopolized by organizations with greater technical capacity. Research therefore needs to distinguish provision of the higher-order object from activation of the collective conversion conditions that make it usable.

Definition 22.148 (Configuration-access profile). *A configuration-access profile records how membership, eligibility, authority, technical capacity, location, time,*

contribution requirements, information, and governance determine differentiated access to a higher-order allocation.

Proposition 22.149 (Collective-capacity incidence). *The existence of a higher-order allocation does not by itself establish equal or effective access among participants; research should identify the governance and conversion mechanisms through which shared capacity becomes differentiated incidence.*

Definition 22.150 (Higher-order performance criterion). *A higher-order performance criterion is a stated property by which a shared configuration is evaluated, such as reliability, redundancy, interoperability, collective learning, resilience, accessibility, coordination quality, or maintenance capacity.*

The criterion should match the purpose of the allocation. A shared health infrastructure can be evaluated through accessibility and continuity; a research platform through knowledge access and collaboration; a public information system through coverage, reliability, and contestability. Different criteria can conflict, so higher-order research should preserve the plurality of performance dimensions relevant to the case.

Proposition 22.151 (Higher-order mechanism condition). *A higher-order allocation claim is warranted when the study identifies a configuration-level mechanism or property that contributes to the outcome beyond the separate possession of resources by individual participants.*

22.4.4 Enabling Conditions

Allocation becomes effective through conditions that can lie outside the allocated object itself. A scholarship can require transport and time; a digital entitlement can require connectivity, identity documentation, and literacy; capital equipment can require maintenance and complementary skills; legal rights can require accessible institutions; care support can require staffing and scheduling. Research on enabling conditions therefore reconstructs the complementary architecture through which a nominal allocation is converted into practical capacity.

Definition 22.152 (Allocation enabling condition). *An allocation enabling condition is a resource, relation, capability, infrastructure, permission, service, temporal condition, informational condition, or institutional arrangement whose presence materially affects conversion of an allocation into its intended or observed practical use.*

Definition 22.153 (Enabling bundle). *An enabling bundle is the set of complementary conditions jointly required for a specified allocation pathway to operate within the research domain under study.*

Enabling bundles can be conjunctive, partially substitutable, sequential, or threshold-dependent. Research should therefore avoid treating complementary conditions as a flat list. The structure of complementarity can explain why equal nominal allocations produce heterogeneous outcomes.

Definition 22.154 (Conversion bottleneck). *An allocation conversion bottleneck is an enabling condition whose scarcity, delay, inaccessibility, or failure materially limits conversion of an otherwise available allocation into effective use.*

Proposition 22.155 (Bottleneck identification value). *Where an allocation produces persistently heterogeneous effective incidence, identifying conversion bottlenecks can provide a more discriminating explanation than increasing the recorded quantity of the*

allocated object alone.

This proposition is a research heuristic rather than a general policy rule. Additional quantity can itself relax a bottleneck in some settings, and an apparent bottleneck can reflect strategic behavior, measurement error, or omitted institutional conditions. The programme should test the mechanism.

Definition 22.156 (Enabling substitution profile). An *enabling substitution profile* specifies which enabling conditions can compensate for one another, over what range, at what cost, and with which distributional or relational consequences.

Proposition 22.157 (Enabling-condition heterogeneity). *Comparative allocation research should treat heterogeneous enabling conditions as candidate explanations for heterogeneous effective incidence when those conditions vary systematically across recipients, relations, organizations, places, or time.*

22.4.5 Relational Consequences

Relational consequences research studies how allocation changes positions and relations beyond direct use of the allocated object. An allocation can alter bargaining alternatives, dependence, authority, trust, reciprocity, coordination capacity, social recognition, organizational membership, creditor exposure, or access to future partners. Such consequences can be beneficial, burdensome, mixed, or differently distributed among affected positions.

Definition 22.158 (Relational consequence). A *relational consequence* is an attributable change in the condition, structure, or feasible development of one or more economically relevant relations following an allocation.

Definition 22.159 (Allocation transmission chain). An *allocation transmission chain* is a temporally and institutionally specified sequence through which an allocation affects intermediate positions, decisions, relations, or configurations before a selected downstream consequence is realized.

Transmission chains discipline claims about spillovers. A grant to a firm can affect employment through investment, demand, organizational strategy, or substitution; a household transfer can affect care relations through time use and bargaining; infrastructure can change local opportunity through accessibility and firm location. The existence of a plausible story provides a hypothesis; research needs evidence linking the relevant steps.

Definition 22.160 (Dependency shift). A *dependency shift* is a change in the extent, direction, concentration, substitutability, or institutional basis of dependence among economic positions following an allocation.

Proposition 22.161 (Dependency redistribution condition). *An allocation that reduces dependence on one relation can increase dependence on another; claims of reduced dependency should therefore identify the relevant comparison set and any material displacement of dependence.*

Definition 22.162 (Relational spillover). A *relational spillover* is an allocation-induced consequence affecting economically relevant relations or positions outside the primary recipient boundary through an identifiable transmission mechanism.

Proposition 22.163 (Spillover attribution condition). *Relational spillovers should be attributed to an allocation only where the proposed transmission pathway is empirically, historically, formally, or interpretively supported at a level proportionate to the*

claim.

A relational consequence can also involve institutional performativity. Eligibility categories, scoring systems, ownership rules, or reporting requirements can create new identities and incentives. Research should therefore examine the allocation procedure itself when classification changes behavior or social position.

Definition 22.164 (Allocation-induced classification effect). An *allocation-induced classification effect* is a change in behavior, recognition, eligibility strategy, institutional treatment, or relational position generated partly by the categories and rules through which allocation is administered.

22.4.6 Long-Horizon Effects

Long-horizon allocation research examines consequences that emerge after the immediate allocation episode through accumulation, learning, maintenance, institutionalization, path dependence, delayed burden, capability formation, or option change. The objective is to identify which present allocations alter future feasible trajectories and which effects dissipate after short-lived incidence. This domain links allocation research to GRE's broader concern with generativity while preserving the distinction between an allocation and the later processes through which consequences develop.

Definition 22.165 (Long-horizon allocation effect). A *long-horizon allocation effect* is a consequence of allocation that becomes economically material through delayed, cumulative, persistent, path-dependent, or intergenerational processes beyond the immediate incidence horizon.

Definition 22.166 (Allocation option effect). An *allocation option effect* is an attributable change in the set, quality, accessibility, reversibility, or distribution of later feasible actions or relations generated through an allocation and its subsequent conversion pathways.

Option effects can involve creation or foreclosure. Education can widen some occupational options; debt can finance capability while creating repayment constraints; infrastructure can enable access while locking in a technological standard; organizational funding can sustain research while orienting future dependence toward a particular sponsor. Research should state the option domain and horizon being evaluated.

Definition 22.167 (Maintenance liability). A *maintenance liability* is a future resource, labor, knowledge, institutional, ecological, or financial requirement generated by an allocation whose satisfaction is necessary to preserve the allocated capacity or prevent deterioration.

Proposition 22.168 (Maintenance-inclusive evaluation). *Where maintenance liabilities are material to persistence, long-horizon evaluation should include them in the allocation's future incidence rather than treat initial provision as the complete economic event.*

Definition 22.169 (Intertemporal allocation incidence). *Intertemporal allocation incidence* is the distribution of benefits, burdens, risks, control, capability, maintenance obligations, and option effects across relevant positions and time horizons following an allocation.

Proposition 22.170 (Temporal mechanism discipline). *Claims that present allocation generates long-horizon outcomes should identify the persistence, accumulation, learn-*

ing, institutionalization, maintenance, or feedback mechanism that connects the allocation episode to the later effect.

Long horizons increase uncertainty. Scenario analysis, historical analogues, longitudinal data, sensitivity analysis, simulation, and adaptive monitoring can support investigation while retaining uncertainty as part of the claim. Long-horizon allocation research should therefore distinguish observed persistence from projected consequence.

22.4.7 Allocation under Asymmetry

Allocation under asymmetry research examines how unequal resources, capabilities, information, institutional positions, bargaining alternatives, waiting capacity, knowledge, documentation, or rule-setting authority shape both the allocation process and its consequences. The research object includes asymmetry before allocation, power exercised through allocation procedures, heterogeneous conversion after receipt, and asymmetries generated or reproduced by allocation itself.

Definition 22.171 (Allocation-asymmetry profile). An *allocation-asymmetry profile* records the dimensions of asymmetry plausibly relevant to an allocation process, the positions among which they occur, their evidential basis, and the mechanisms through which they may affect eligibility, timing, quantity, conditions, conversion, or consequence.

Definition 22.172 (Allocation power position). An *allocation power position* is a situated capacity to influence an allocation's rules, categories, information, timing, eligibility, interpretation, enforcement, or conversion conditions in ways consequential for one's own or others' incidence.

Definition 22.173 (Procedural allocation asymmetry). A *procedural allocation asymmetry* is an unequal capacity to access, navigate, contest, influence, delay, accelerate, or reinterpret the procedures through which allocation is determined or implemented.

Procedural asymmetry can be empirically important even when a formal rule is uniform. Documentation requirements, application complexity, appeal capacity, information timing, professional representation, or administrative discretion can generate differentiated effective access. Research can investigate these mechanisms through administrative process data, legal and institutional analysis, ethnography, audit studies, experiments, or comparative case designs where ethically and institutionally appropriate.

Definition 22.174 (Asymmetric conversion). *Asymmetric conversion* is a patterned difference in the capacity of differently situated recipients or relations to transform comparable nominal allocations into effective use, control, capability, or future options.

Proposition 22.175 (Asymmetry-sensitive incidence). *Where pre-existing asymmetries materially affect allocation conversion or transmission, equal nominal allocation does not establish equal effective incidence; research should identify the mechanisms producing the difference.*

Definition 22.176 (Allocation capture risk). *Allocation capture risk* is the possibility that actors with advantaged positions redirect a material share of an allocation's resources, control, recognition, access, or future return toward themselves through

mechanisms not represented by the intended recipient rule.

Proposition 22.177 (Capture identification burden). *A claim of allocation capture requires evidence of both an advantaged redirection mechanism and a material divergence between intended or stated incidence and realized control, benefit, access, or return.*

The asymmetry analysis should avoid equating unequal outcomes with capture. Differences can also arise from legitimate priority rules, heterogeneous needs, conversion conditions, uncertainty, or administratively justified distinctions. The research burden is mechanism-specific.

22.4.8 Comparative Evaluation

Comparative evaluation brings the preceding research domains together by comparing alternative allocation architectures rather than isolated quantities. The analytical object can include who formally receives the allocation, what is allocated, which enabling conditions are provided, how relations and higher-order structures change, how consequences develop over time, and how asymmetries shape effective incidence. The objective is to make differences among allocation arrangements auditable without forcing heterogeneous outcomes into a single metric where commensurability is unsupported.

Definition 22.178 (Comparative allocation frame). *A comparative allocation frame specifies the allocation alternatives, domain, affected positions, time horizon, mechanisms, evidential standards, and evaluative dimensions used to compare allocation architectures.*

Definition 22.179 (Allocation evaluation vector). *An allocation evaluation vector is a structured set of empirically and normatively relevant dimensions retained separately for comparison, such as effective access, capability, distribution, relational consequences, higher-order performance, maintenance burden, reversibility, power concentration, risk, and future option effects.*

The vector form is conceptual rather than a requirement for numerical measurement. Some dimensions can be quantified; others may require ordinal, qualitative, legal, historical, or participatory assessment. The framework preserves their distinction unless a defensible conversion rule exists.

Definition 22.180 (Allocation comparison remainder). *An allocation comparison remainder is a material difference among allocation architectures that remains insufficiently represented by the selected common comparison dimensions or cannot be defensibly converted into the comparison metric being used.*

Proposition 22.181 (Comparative remainder preservation). *Comparative allocation research should preserve material remainders explicitly where common metrics omit affected relations, heterogeneous values, institutional meanings, long-horizon liabilities, or distributional differences relevant to the research or evaluative purpose.*

Definition 22.182 (Allocation transfer condition). *An allocation transfer condition is a contextual property that should remain sufficiently similar, explicitly modeled, or adjusted before an allocation result from one institutional, historical, social, or technological setting is used to support expectations in another.*

Proposition 22.183 (Comparative transfer discipline). *Evidence that an allocation architecture performs well in one setting supports transfer only to the extent that the mech-*

anisms and enabling conditions responsible for that performance remain plausible in the target setting.

Comparative evaluation can also examine alternative allocation rules within the same setting. Equal shares, need-responsive allocation, capability-oriented allocation, priority rules, lotteries, market allocation, negotiated allocation, infrastructure provision, and mixed arrangements can be compared through their locally relevant mechanisms and consequences. GRE does not supply one universal ranking among them. The programme supplies a structure for making the empirical, relational, temporal, and normative basis of comparison explicit.

Definition 22.184 (Relational-allocation research portfolio). *A relational-allocation research portfolio is a coordinated set of studies covering complementary allocation levels, mechanisms, domains, time horizons, and comparison settings so that evidence can accumulate without treating one representation as exhaustive.*

Proposition 22.185 (Relational-allocation programme condition). *A cumulative GRE research programme on allocation should connect recipient-level incidence, relational and higher-order mechanisms, enabling conditions, asymmetries, temporal consequences, and comparative evaluation through explicit interfaces while allowing each empirical project to retain a bounded claim envelope.*

Section 22.4 therefore treats relational allocation as a family of research problems rather than a universal allocation formula. Its programme value lies in making visible where conventional recipient-centered analysis is sufficient, where conversion or relational mechanisms materially alter incidence, and where future research should discriminate among competing allocation architectures. The next section turns to heterogeneous value, whose identification and plurality condition many of the evaluative and conversion problems that allocation research encounters.

22.5 Research on Heterogeneous Value

The role of this section is to convert GRE's plural account of value into a research programme with explicit identification rules, evidential burdens, comparison procedures, and revision conditions. Its objective is to specify how researchers can investigate whether distinct value forms are empirically warranted, how several forms coexist within the same economic configuration, where commensuration is locally possible or materially lossy, how value becomes manifest and institutionally recognized, where conversion interfaces appear, how value conflicts are structured, and how value categories and valuation regimes transform historically. The discussion proceeds through these eight research domains. The method is plural and diagnostic: quantitative measures, qualitative inquiry, historical reconstruction, institutional analysis, participatory research, formal representation, and comparative study are treated as potentially complementary forms of access whose adequacy depends on the local value claim.

Research on heterogeneous value should avoid two symmetrical errors. One error reduces economically relevant significance to a single scalar representation whenever a price, score, or common metric is available. The other multiplies value categories so freely that every observed difference is treated as a distinct value form. GRE instead requires a researchable relation among the value-bearing condition, the affected or valuing position, the proposed value form, the manifestation through which

it becomes legible, the institutional or social recognition it receives, and the evidence supporting the distinction.

Definition 22.186 (Heterogeneous-value research object). A *heterogeneous-value research object* is a provisionally bounded economic configuration in which two or more candidate value forms, valuing positions, manifestations, recognition regimes, or historical value conditions are distinguished because their differences are potentially material to explanation, evaluation, allocation, governance, or later generative consequences.

Definition 22.187 (Value-form identification warrant). A *value-form identification warrant* is the empirical, historical, institutional, interpretive, formal, or comparative basis for treating a proposed mode of economic significance as analytically distinct within a specified inquiry.

Proposition 22.188 (Value-form non-proliferation condition). A *proposed value form* should be retained as a distinct research category only where the distinction changes at least one materially relevant claim concerning realization conditions, affected positions, measurement, conversion, conflict, institutional recognition, temporal development, or policy consequence.

Proposition 22.188 makes heterogeneity answerable to research. A distinction can be conceptually elegant yet empirically idle. Conversely, two phenomena represented by the same monetary amount can require different value-form treatment when they depend on different realization conditions or produce different relational, capability, ecological, epistemic, institutional, or future consequences. The research task is therefore to test which distinctions do analytical work in the case at hand.

Table 22.5 summarizes the eight research domains and their principal evidential burdens.

22.5.1 Identification of Value Forms

Research on value-form identification asks when a difference in economic significance warrants treatment as a distinct analytical form. The objective is not to recover a final taxonomy. It is to make the current taxonomy corrigible by connecting value-form distinctions to observable realization conditions, institutional practices, affected positions, and consequences. A value form can be provisionally identified through recurrent differences in what must be present for the relevant significance to be realized, how the significance is manifested or recognized, what can destroy or preserve it, and which decisions change when the distinction is retained.

Definition 22.189 (Value-form attribution profile). A *value-form attribution profile* records, for a proposed value form, the bearer or affected configuration, valuing position, realization conditions, characteristic manifestations, recognition mechanisms, temporal horizon, relevant consequences, and evidence supporting the attribution.

The profile permits the same object to participate in several forms without requiring that those forms be substances contained in the object. A laboratory can carry material significance through equipment and space, epistemic significance through knowledge production, relational significance through collaboration, institutional significance through accredited procedures, capability significance through what users can effectively do, and option significance through future research possibilities. The question is whether these distinctions are supported by different realization or fail-

Table 22.5: Principal research domains in heterogeneous value

Research domain	Primary object	Characteristic evidence	Principal research burden
Identification of value forms	Candidate modes of economic significance	Use conditions, institutional practice, actor judgments, consequences, comparative cases	Show that the distinction changes explanation or evaluation
Value plurality	Coexisting forms, bearers, valuers, and horizons	Multi-domain indicators, qualitative accounts, institutional records, participatory evidence	Distinguish genuine plurality from redundant classification
Value incommensurability	Limits of common comparison or aggregation	Failed rankings, unstable trade-offs, residual judgments, institutional practice	Localize the domain and degree of non-commensuration
Value manifestation	Prices, scores, narratives, classifications, symbols, and other representations	Measurement systems, discourse, administrative records, market data, observation	Separate represented value from the representation interface
Value recognition	Social and institutional acknowledgment of significance	Law, standards, budgets, credentials, status systems, governance procedures	Distinguish recognition from existence and trace recognition incidence
Value conversion	Apparent source–target transitions among value forms	Process tracing, interface records, institutional rules, before–after representations	Identify source and target forms without presuming equivalence
Value conflict	Competing value claims and affected positions	Deliberation, litigation, organizational decisions, contested metrics, distributional evidence	Identify the structure of conflict without forcing one common metric
Historical transformation	Change in value-bearing conditions, forms, valuation, and knowledge	Archives, longitudinal data, institutional histories, changing classifications and metrics	Distinguish historical change in value from change in its representation

ure conditions and whether those differences matter to the inquiry.

Definition 22.190 (Empirically distinguishable value form). An *empirically distinguishable value form* is a proposed value form for which available evidence supports at least one recurrent difference in realization conditions, manifestation, recognition, vulnerability, conversion, conflict, or consequence that cannot be represented without material loss by the comparison category used in the study.

Definition 22.191 (Analytical value distinction). An *analytical value distinction* is a conceptual separation introduced to clarify reasoning even where current evidence

does not establish that the distinguished forms are empirically separable in the domain under study.

Proposition 22.192 (Identification-status discipline). *Research should report whether a value-form distinction is empirically supported, analytically useful, provisionally hypothesized, or unresolved rather than allowing conceptual inclusion in GRE to imply empirical establishment.*

This status discipline is especially important where value terms carry familiar normative connotations. A claim that a programme generates “relational value” or “participatory value” should identify what relation or participation changes, for whom, under which conditions, and with what evidence. Naming a value form is not evidence that the relevant significance exists.

Definition 22.193 (Value-form boundary test). *A value-form boundary test compares cases in which a candidate value form varies while closely related forms remain as similar as feasible, or in which the candidate form remains stable while related forms vary, in order to assess whether the distinction carries independent explanatory or evaluative information.*

Boundary tests need not take experimental form. Historical comparison, natural variation, matched institutional cases, qualitative contrast, and process tracing can all help determine whether an apparent value-form difference merely redescribes another dimension.

22.5.2 Value Plurality

Value-plurality research examines configurations in which several forms of significance coexist and cannot be adequately represented through a single value coordinate for the question at hand. Plurality can occur because one bearer realizes several forms, because different affected subjects value the same configuration differently, because institutions apply several evaluative registers, or because short- and long-horizon consequences diverge.

Definition 22.194 (Value-plurality profile). *A value-plurality profile specifies the value forms, bearers, valuers, affected positions, manifestations, recognition regimes, scales, and temporal horizons that are materially relevant to a bounded economic configuration.*

Proposition 22.195 (Plurality attribution condition). *A claim of value plurality is strengthened where the retained value dimensions respond differently to interventions, depend on different realization conditions, generate different conflicts or losses, or support different judgments across affected positions.*

Plurality research should also distinguish heterogeneity of value from heterogeneity of preference. Two individuals can assign different amounts of the same evaluative metric to an outcome. Conversely, the same person or institution can judge one outcome through several irreducible dimensions. The former can sometimes be represented within a single metric with heterogeneous weights; the latter may require a plural architecture.

Definition 22.196 (Intra-position value plurality). *Intra-position value plurality occurs when one valuing or affected position treats more than one value form as materially relevant to judgment or action within the same inquiry.*

Definition 22.197 (Inter-position value plurality). *Inter-position value plurality oc-*

curs when different affected or valuing positions organize significance through different value forms, rankings, thresholds, or temporal horizons.

Proposition 22.198 (Plurality non-redundancy condition). *A plural value representation adds analytical content only where retaining the distinct dimensions changes inference, diagnosis, comparison, or decision relative to a simpler representation.*

The proposition encourages empirical parsimony without assuming scalar reduction. Researchers can compare models with one, several, or nested value dimensions and test where additional dimensions improve prediction, explanation, interpretation, or accountability. In qualitative work, the analogous task is to establish whether participants or institutions recurrently distinguish value claims that would disappear under a single category.

22.5.3 Value Incommensurability

Research on incommensurability asks where common measurement, ranking, or substitution is unavailable, unstable, institutionally contested, or materially lossy. GRE treats incommensurability as a scoped research claim rather than a universal property of unlike values. Some values can be locally compared for a specified decision even when no context-independent conversion exists. Others can be ordered only partially, compared through thresholds, or held in unresolved tension.

Definition 22.199 (Local commensurability domain). *A local commensurability domain is a specified decision, institutional setting, population, scale, and time horizon within which two or more value dimensions can be compared or combined through an explicit rule with a known interpretive scope.*

Definition 22.200 (Value incommensurability warrant). *A value incommensurability warrant is evidence that a proposed common ordering, metric, or substitution rule fails to preserve distinctions material to the research question within the stated domain.*

Evidence can include unstable rankings across legitimate decision rules, systematic residual judgments after monetization, institutional refusal to permit substitution, lexical or threshold constraints, participant testimony that a proposed metric misrepresents the good at stake, or observed behavior inconsistent with smooth trade-off assumptions. None of these signs proves metaphysical incommensurability; each can support a bounded claim about the inadequacy of a particular comparison architecture.

Definition 22.201 (Commensuration remainder). *A commensuration remainder is the economically or normatively relevant information about a value-bearing condition that is omitted, compressed, or transformed when heterogeneous values are represented through a common comparison rule.*

Proposition 22.202 (Remainder-sensitive comparison). *Where a common metric is used for practical comparison, research should report material commensuration remainders separately when their omission can alter interpretation, affected-party standing, reversibility, or later consequences.*

Definition 22.203 (Partial comparability). *Partial comparability is a relation in which some alternatives, dimensions, thresholds, or regions can be compared under a specified rule while other comparisons remain unresolved or rule-dependent.*

Proposition 22.204 (Incommensurability localization condition). *An incommensura-*

bility claim should identify the comparison operation that fails, the domain of failure, and the material remainder generated by forcing the operation, rather than inferring unrestricted incomparability from one failed metric.

22.5.4 Value Manifestation

Value-manifestation research studies the forms through which value-bearing conditions become observable, communicable, measurable, symbolized, or administratively actionable. Prices, wages, scores, rankings, narratives, credentials, legal statuses, budget lines, participation rates, ecological indicators, reputation signals, and qualitative judgments can all function as manifestations. The research problem is to identify what relation these manifestations bear to the value claims they are used to support.

Definition 22.205 (Value-manifestation interface). A *value-manifestation interface* is a historically and institutionally situated process through which a value-bearing condition becomes represented in an observable, communicable, measurable, symbolic, or administratively actionable form.

Definition 22.206 (Manifestation gap). A *manifestation gap* is the empirically relevant difference between a value-bearing condition and the representation through which that condition is inferred, judged, compared, or governed.

A wage can manifest one dimension of the value attached to labor while omitting care burdens, capability formation, occupational identity, or bargaining asymmetry. A research citation count can manifest some patterns of uptake while omitting negative findings, mentoring, infrastructure, conceptual influence, or local relevance. A market price can convey scarcity and willingness to exchange within an institutional setting while omitting ecological thresholds or rights constraints. Research should therefore estimate or qualitatively reconstruct the gap appropriate to the claim.

Proposition 22.207 (Manifestation non-exhaustion condition). *Observed agreement in a value manifestation does not establish agreement in the underlying value-bearing conditions unless the manifestation interface is shown to preserve the dimensions relevant to the claim.*

Definition 22.208 (Manifestation provenance). *Manifestation provenance* records how a value representation was produced, including the measurement rule, classification system, institutional authority, data source, aggregation procedure, affected population, and temporal reference relevant to interpretation.

Proposition 22.209 (Representation-change diagnostic). *When a measured value changes, research should distinguish changes in the represented condition from changes in the manifestation interface, measurement rule, coverage, classification, or strategic response to the representation.*

22.5.5 Value Recognition

Recognition research asks how economic significance acquires social, institutional, legal, professional, market, or political standing. Recognition differs from manifestation. A condition can be visible yet institutionally disregarded, or recognized through a legal or organizational category while poorly measured. Recognition can alter access, compensation, authority, eligibility, protection, status, and the ability of a value

claim to influence allocation.

Definition 22.210 (Value-recognition regime). A *value-recognition regime* is the set of rules, practices, authorities, categories, procedures, and conventions through which particular value claims acquire or fail to acquire standing within an economic or institutional configuration.

Definition 22.211 (Recognition incidence). *Recognition incidence* is the distribution of practical benefits, burdens, standing, visibility, rights, or decision influence produced by a value-recognition regime across affected positions.

Definition 22.212 (Recognition asymmetry). A *recognition asymmetry* occurs when otherwise relevant value claims face systematically different prospects of acknowledgment, institutional uptake, evidential credibility, or practical actionability because of differences in position, authority, representation, category membership, or access to recognition interfaces.

Proposition 22.213 (Recognition–existence separation). *Failure of institutional or social recognition does not by itself establish absence of the underlying value-bearing condition, while formal recognition does not by itself establish effective realization of that value.*

This separation makes unrecognized labor, ecological damage, informal knowledge, community stewardship, or future-option loss empirically investigable without presuming that recognition is irrelevant. Recognition can be causally important precisely because it changes whether a condition can enter budgets, rights, compensation, policy, status systems, or organizational attention.

Definition 22.214 (Recognition-interface audit). A *recognition-interface audit* identifies who can submit, validate, contest, revise, or reject value claims within a recognition regime and what evidential, procedural, linguistic, financial, technical, or status requirements condition those actions.

Proposition 22.215 (Recognition-power condition). *Where recognition materially changes allocation, rights, status, or future opportunities, research should treat control over recognition interfaces as a candidate source of economic power rather than as a neutral classificatory procedure.*

22.5.6 Value Conversion

Within this section, research on value conversion has a deliberately limited role. The objective is to identify where empirical or institutional practice appears to connect heterogeneous value forms and to establish the source form, target form, affected positions, and evidential basis for that connection. Detailed research on conversion conditions, rates, nonlinearity, irreversibility, loss, gain, failure, and power belongs to the next section. The present subsection therefore establishes the boundary conditions needed for that programme.

Definition 22.216 (Value-conversion adjacency). A *value-conversion adjacency* is an empirically or institutionally supported relation indicating that realization, recognition, or representation in one value form can participate in producing, enabling, constraining, or making actionable a condition in another value form.

Definition 22.217 (Source–target value specification). A *source–target value specification* identifies the candidate source value form, candidate target value form, conversion interface, relevant positions, temporal ordering, and evidence required before a

conversion mechanism is inferred.

Proposition 22.218 (Conversion-identification condition). *Observed association between two value forms supports a conversion claim only where research can identify a plausible source–target relation and distinguish it from common causes, co-manifestation, simultaneous generation, reclassification, or measurement overlap.*

The condition matters because many value forms are jointly produced. Training can increase capability and wages without wages being the mechanism through which capability was generated. Institutional recognition can accompany reputation because both arise from a common achievement. Ecological restoration can improve property values while also generating ecological significance that is neither caused by nor exhausted by the price change.

Definition 22.219 (Conversion-boundary record). *A conversion-boundary record documents the evidence sufficient to posit a source–target interface while preserving unresolved questions about mechanism, magnitude, reversibility, remainder, gain, loss, and governance for dedicated conversion research.*

Proposition 22.220 (Conversion non-equivalence condition). *Evidence that one value form can be converted into or made actionable through another does not establish that the source and target forms are equivalent, mutually substitutable, or fully represented by a common metric.*

22.5.7 Value Conflict

Value-conflict research examines situations in which economically relevant value claims cannot all be jointly realized, recognized, preserved, or prioritized under the available constraints. Conflict can occur among value forms, among subjects, among institutions, across temporal horizons, or between a local valuation regime and a broader legal, ecological, political, or organizational order. The research aim is to reconstruct the structure of the conflict before evaluating its resolution.

Definition 22.221 (Value-conflict configuration). *A value-conflict configuration specifies the competing value claims, affected positions, institutional or material constraints, decision authority, temporal horizons, available compromises, and known remainders that organize a bounded conflict.*

Definition 22.222 (Value-conflict mechanism). *A value-conflict mechanism is the process through which pursuit, recognition, or preservation of one value claim changes the feasible realization of another within the specified configuration.*

Conflicts can be direct, as when land use for one purpose excludes another, or mediated, as when budget rules make monetary cost the operative constraint on care quality, ecological restoration, or participation. Some apparent conflicts can disappear when enabling conditions change. Others persist because the underlying claims concern different subjects, rights, thresholds, or temporal horizons.

Definition 22.223 (Value-conflict remainder). *A value-conflict remainder is a value claim, affected-party interest, historical burden, or future consequence that remains materially unresolved after a decision, compromise, aggregation, compensation, or institutional settlement.*

Proposition 22.224 (Conflict-resolution non-closure). *An institutional decision that settles action does not by itself establish resolution of the underlying value conflict; research should preserve material conflict remainders where they continue to affect legit-*

imacy, behavior, distribution, or later trajectories.

Definition 22.225 (Conflict-governance profile). *A conflict-governance profile records who has standing, what evidence and value representations are admissible, how trade-offs or thresholds are determined, what appeal or revision mechanisms exist, and how unresolved remainders are treated.*

Proposition 22.226 (Value-conflict comparability condition). *Comparative research on value conflicts should compare conflict structures and governance mechanisms before comparing outcomes, because similar outcomes can arise from materially different distributions of standing, authority, recognition, and unresolved remainder.*

22.5.8 Historical Transformation of Value

Historical-value research examines how value-bearing conditions, value forms, manifestations, recognition regimes, conflicts, and knowledge about value change over time. Its role in the research programme is to prevent present categories from being projected backward as timeless measures and to make the current GRE value taxonomy revisable. The method combines archival reconstruction, longitudinal measurement, institutional history, discourse and classification analysis, material history, and retrospective re-epistemization where later evidence changes what can responsibly be inferred about earlier conditions.

Definition 22.227 (Historical value-state profile). *A historical value-state profile records, for a specified period and configuration, the relevant value-bearing conditions, recognized value forms, valuing positions, manifestations, recognition regimes, comparison practices, conflicts, and available epistemic warrants.*

Definition 22.228 (Value-form emergence). *Value-form emergence* is the historically situated process through which a mode of economic significance becomes sufficiently recurrent, differentiated, manifested, or institutionally consequential to warrant treatment as a distinct value form in a research programme.

Definition 22.229 (Value-form attenuation). *Value-form attenuation* is a historical decline in the practical salience, institutional recognition, empirical distinctness, or explanatory usefulness of a previously identified value form within a specified domain.

Proposition 22.230 (Historical taxonomy revisability). *A GRE value taxonomy should be revised when historical or comparative evidence shows that existing forms systematically collapse materially different realization conditions or retain distinctions that no longer carry explanatory or evaluative content in the domain studied.*

Historical transformation also requires separation among changes in value-bearing conditions, changes in representation, and changes in knowledge. A pollutant can impose harm before measurement establishes its magnitude. Unpaid work can sustain reproduction before statistical systems represent it. A credential can gain signaling importance while the underlying capability changes little. New evidence can revise earlier judgments without implying that the earlier material or relational conditions changed at the moment of re-evaluation.

Definition 22.231 (Value re-epistemization event). *A value re-epistemization event* is a historically locatable change in evidence, concept, measurement, standpoint, or interpretive procedure that materially revises the warranted characterization of a value claim.

Proposition 22.232 (Historical differentiation condition). *Historical research should*

distinguish change in value-bearing conditions from change in value form, manifestation, recognition, valuation practice, and epistemic warrant wherever collapsing these processes would materially alter the explanation.

Definition 22.233 (Heterogeneous-value research portfolio). *A heterogeneous-value research portfolio is an organized set of studies that jointly test value-form identification, plurality, commensurability boundaries, manifestation, recognition, conversion adjacency, conflict, and historical transformation across domains while recording revisions to the value taxonomy.*

Proposition 22.234 (Portfolio-level value discipline). *A cumulative research programme on heterogeneous value should permit both expansion and contraction of its value taxonomy, preserve provenance for category revisions, and distinguish domain-specific value forms from claims intended to travel across domains.*

The portfolio perspective closes the section by making heterogeneous value a cumulative research problem rather than a fixed catalogue. A value form earns continued use through explanatory, empirical, interpretive, or evaluative work; a manifestation earns trust through validated relation to the condition it represents; recognition regimes remain objects of causal and power analysis; incommensurability claims remain local and revisable; and historical evidence can alter the categories themselves. The next section can therefore examine value conversion with a more disciplined source taxonomy and clearer evidence about which distinctions conversion processes must preserve, transform, or leave as remainder.

22.6 Research on Value Conversion

The role of this section is to convert GRE's conceptual account of value conversion into a research programme with explicit units of analysis, evidential burdens, comparative procedures, and revision conditions. Section 22.5 established the source-side discipline required for this task by distinguishing value forms, manifestations, recognition regimes, and conversion adjacencies. The present section asks how conversion processes can be identified and studied once a plausible source–target relation has been specified. Its objective is to examine the interfaces through which conversion occurs, the conditions that make conversion feasible, the local representation of conversion rates, nonlinear and irreversible transformations, conversion loss and gain, failed conversion, and power over conversion. The method is mechanism-oriented and plural: process tracing, quantitative estimation, institutional analysis, historical reconstruction, qualitative inquiry, comparative research, and formal modeling can all contribute where their assumptions match the conversion process under study.

Value conversion should be treated as a typed transformation rather than as movement of a homogeneous substance. Source and target value forms can differ in realization conditions, units of manifestation, institutional standing, temporal horizon, affected positions, and normative significance. A conversion claim therefore requires more than observing that one measured quantity precedes another. It requires a defensible account of the interface, the source condition, the target condition, the enabling and constraining circumstances, the affected positions, and the causal or institutional process linking them.

Definition 22.235 (Value-conversion research object). *A value-conversion research object is a provisionally bounded process in which an identified source value form*

becomes realizable, legible, actionable, institutionally effective, or generatively consequential through a different target value form or practical register, with sufficient evidence to investigate the mechanism linking source and target.

Definition 22.236 (Conversion episode). A *conversion episode* is an empirically delimited occurrence of a candidate conversion process, specified by source state, target state, conversion interface, relevant positions, temporal interval, enabling conditions, and observable or reconstructable consequences.

Proposition 22.237 (Conversion provenance condition). *Research on value conversion should preserve enough provenance to distinguish transformation of a source value form from co-generation, reclassification, simultaneous manifestation, common-cause association, transfer, circulation, and measurement substitution whenever those alternatives would materially change the explanation.*

Table 22.6 summarizes the nine research domains and the principal burdens attached to them.

22.6.1 Conversion Interfaces

Conversion-interface research identifies the practical arrangements through which a source value form can become effective in a target form. The research object is broader than a physical or digital point of exchange. Markets, credentialing systems, courts, licensing regimes, standards bodies, platforms, professional communities, schools, banks, public agencies, ecological processes, organizational routines, and interpersonal relations can all function as interfaces where they mediate a typed source–target transformation. The task is to identify which interface functions are causally or institutionally material in the case under study.

Definition 22.238 (Conversion-interface profile). A *conversion-interface profile* records the source and target value forms, interface operators or institutions, access rules, admissible inputs, validation procedures, complementary requirements, temporal sequence, burdens, rights, contestation procedures, and known remainders associated with a specified conversion process.

An interface can perform several functions simultaneously. It can certify a source condition, translate one representation into another, authorize access, price an entitlement, validate evidence, combine complementary inputs, allocate risk, impose a standard, or filter claims. Research should therefore avoid treating “the interface” as a black box when different internal functions are relevant to success, failure, incidence, or power.

Definition 22.239 (Interface-function decomposition). An *interface-function decomposition* separates the materially relevant functions performed within a conversion interface, such as validation, translation, authorization, pricing, aggregation, certification, matching, sequencing, or exclusion.

Proposition 22.240 (Interface mechanism condition). *A conversion-interface explanation is strengthened when research identifies which interface function changes the feasibility or form of the target outcome and provides evidence that the same result would not be expected under materially different interface conditions.*

Several interfaces can connect the same source and target forms. Formal education, professional certification, portfolios, apprenticeship, and prior employment can each convert knowledge or demonstrated competence into labor-market eligibility

Table 22.6: Principal research domains in value conversion

Research domain	Primary object	Characteristic evidence	Principal research burden
Conversion interfaces	Institutional, technical, legal, relational, material, or epistemic conversion sites	Rules, process traces, workflow records, contracts, standards, interviews, observed practices	Identify the interface and distinguish its enabling, filtering, and gatekeeping functions
Conversion conditions	Necessary, enabling, complementary, threshold, and constraining conditions	Comparative cases, eligibility records, infrastructure, legal status, skills, timing, access conditions	Distinguish source possession from effective convertibility
Conversion rates	Local source–target response under specified conditions	Longitudinal data, experiments, quasi-experiments, administrative data, calibrated models	Define a meaningful local rate without presuming universal commensurability
Nonlinear conversion	Thresholds, saturation, amplification, interaction, and regime change	Dose–response patterns, discontinuities, heterogeneous effects, mechanism evidence	Identify the mechanism producing nonlinearity and its domain
Irreversible conversion	Path-dependent transformation and incomplete recoverability	Historical sequences, restoration attempts, sunk commitments, option loss, hysteresis evidence	Separate practical irreversibility from temporary cost or delayed reversal
Conversion loss	Source dimensions, rights, options, relations, or capacities diminished through conversion	Remainder audits, affected-party evidence, before–after comparison, ecological or institutional records	Localize loss and its incidence without forcing unlike losses into one scalar
Conversion gain	New or amplified value generated through conversion	Target-side outcomes, complementarities, spillovers, capability or institutional effects	Distinguish generated gain from relabeling or redistribution
Failed conversion	Attempted conversion that does not realize the specified target under the relevant conditions	Failed applications, rejected claims, implementation records, null outcomes, negative cases	Identify failure mode rather than treating all unsuccessful outcomes as equivalent
Power over conversion	Control over access, terms, classification, recognition, pricing, or alternatives	Governance records, ownership, bargaining positions, appeals, exclusion patterns, interface design	Trace how control changes conversion possibility, incidence, and distribution

under different institutional settings. Their coexistence creates a comparative research problem rather than a single conversion rule.

Definition 22.241 (Interface multiplicity). *Interface multiplicity* exists when two or more institutionally or technically distinct interfaces can connect the same specified source and target value forms within a defined domain.

Definition 22.242 (Interface substitutability profile). An *interface substitutability profile* records the extent to which alternative interfaces produce comparable target access, burdens, delays, recognition, rights, risks, or remainders for the relevant source positions.

Proposition 22.243 (Alternative-interface comparison condition). *Where interface multiplicity exists, comparative research should examine whether apparent substitutability survives comparison of eligibility, burden, delay, affected positions, recognition status, and later consequences rather than comparing target labels alone.*

22.6.2 Conversion Conditions

Conversion-condition research asks what must be present, absent, sequenced, or maintained for an identified interface to produce the specified target outcome. The distinction between source possession and convertibility is central. Money may fail to become medical access where providers, insurance status, transport, language assistance, documentation, or time are missing. Knowledge may fail to become accredited qualification where recognition procedures exclude the source institution. A legal entitlement may fail to become effective control where enforcement capacity is weak.

Definition 22.244 (Conversion-condition set). A *conversion-condition set* is the collection of source attributes, complementary resources, institutional permissions, relational conditions, technical capacities, temporal requirements, and contextual states that materially affect whether a specified conversion can occur through a specified interface.

Definition 22.245 (Necessary conversion condition). A *necessary conversion condition* is a condition whose absence, within the defined domain and interface, blocks the specified target realization even when other observed requirements are present.

Definition 22.246 (Enabling conversion condition). An *enabling conversion condition* is a condition that increases the feasibility, reliability, magnitude, speed, or durability of conversion without being required in every admissible case.

Definition 22.247 (Conversion complementarity). *Conversion complementarity* occurs when two or more conditions jointly enable or materially amplify conversion in a way that cannot be represented adequately by treating their contributions as independent within the relevant domain.

Complementarity matters for empirical identification because equal source quantities can generate different target outcomes under different bundles of supporting conditions. Research that estimates an average source–target relationship while omitting complementary conditions can misattribute the mechanism to the source alone.

Proposition 22.248 (Convertibility-incidence condition). *Where conversion conditions are unevenly distributed, research should distinguish the distribution of source value from the distribution of effective convertibility and identify which positions bear the burdens of satisfying the relevant conditions.*

Definition 22.249 (Conversion bottleneck). A *conversion bottleneck* is a condition, interface capacity, authorization, resource, or relational dependency whose scarcity or restricted accessibility materially limits conversion despite the availability of other required inputs.

Proposition 22.250 (Condition-specific intervention test). *A proposed intervention on conversion should specify which conversion condition or bottleneck it changes and what observable alteration in conversion feasibility or target realization would support the proposed mechanism.*

22.6.3 Conversion Rates

Conversion-rate research studies how variation in a source condition relates to variation in a target condition under a specified interface and condition set. The term “rate” should remain local. Heterogeneous value forms often lack a common natural unit, and a useful conversion study can therefore estimate probabilities, elasticities, threshold transitions, categorical changes, time-to-conversion, ordered outcomes, or domain-specific response functions rather than one universal coefficient.

Definition 22.251 (Local conversion-rate representation). A *local conversion-rate representation* is an empirically or formally justified description of how changes in a specified source measure are associated with or causally related to changes in a specified target measure under a defined interface, condition set, population, scale, and time horizon.

Definition 22.252 (Conversion denominator discipline). *Conversion denominator discipline* requires a study to state what population, opportunity set, eligible source set, attempted-conversion set, or exposure period forms the denominator of any reported conversion probability, rate, or success measure.

The denominator can materially alter conclusions. A scholarship programme can show a high graduation rate among admitted participants while converting only a small share of qualified applicants into actual participation. A platform can show high monetization among active creators while most registered creators never reach the eligibility threshold. Both rates can be valid while answering different questions.

Proposition 22.253 (Rate-domain condition). *A reported conversion rate should be interpreted only within the population, interface, condition set, scale, and temporal horizon for which the source and target measures retain their intended meaning.*

Definition 22.254 (Conversion-rate heterogeneity). *Conversion-rate heterogeneity* is systematic variation in conversion response across positions, groups, interfaces, institutional regimes, scales, or historical periods that remains material after accounting for the source measure used in the study.

Proposition 22.255 (Average-rate insufficiency condition). *Where conversion-rate heterogeneity changes substantive interpretation, distribution, or policy implication, research should report the relevant heterogeneity rather than relying solely on an aggregate average.*

Conversion-rate estimates can support comparison while preserving source–target non-equivalence. A study may estimate how additional training changes the probability of recognized qualification without implying that hours of training and institutional status share a common value substance. The empirical relationship is conditional and typed.

22.6.4 Nonlinear Conversion

Nonlinear-conversion research examines cases in which proportional change in the source does not produce proportional change in the target. Thresholds, saturation, complementarities, increasing or decreasing returns, congestion, network effects, institutional discontinuities, and sequence dependence can all generate nonlinear conversion patterns. The research burden is to identify the mechanism producing the shape rather than treating nonlinearity as a generic marker of complexity.

Definition 22.256 (Conversion threshold). A *conversion threshold* is a source, complementary-condition, or interface state at which a relatively small additional change produces a materially different conversion possibility or target outcome within the specified domain.

Definition 22.257 (Conversion saturation). *Conversion saturation* occurs when additional source input produces progressively smaller target changes because a complementary condition, interface capacity, target ceiling, or other limiting mechanism becomes binding.

Definition 22.258 (Conversion amplification). *Conversion amplification* occurs when changes in source input generate disproportionately large target effects through complementarity, network reinforcement, institutional recognition, cumulative learning, or another specified mechanism.

Proposition 22.259 (Nonlinearity mechanism requirement). *Evidence of a nonlinear source–target association supports a nonlinear conversion mechanism only when the proposed threshold, saturation, amplification, interaction, or regime-change process is independently plausible and materially improves explanation over alternative sources of curvature or selection.*

Definition 22.260 (Conversion regime). A *conversion regime* is a bounded range of source states, conditions, and interface arrangements within which the conversion process exhibits a sufficiently stable mechanism or response pattern for comparative analysis.

Proposition 22.261 (Regime-specific inference condition). *Inferences estimated within one conversion regime should travel to another only where the mechanism, source and target meanings, and relevant condition set remain sufficiently comparable.*

22.6.5 Irreversible Conversion

Irreversible-conversion research studies transformations whose relevant source state cannot be restored by a practically available reverse process within the time, resource, institutional, or ecological conditions of the inquiry. Irreversibility can arise through material depletion, institutional lock-in, loss of tacit knowledge, destruction of relationships, sunk specialization, ecological threshold crossing, legal finality, or option foreclosure. The research problem is to distinguish these mechanisms from high but temporary reversal cost.

Definition 22.262 (Practical conversion irreversibility). *Practical conversion irreversibility* exists when restoration of the materially relevant source condition is infeasible within the specified temporal horizon and available institutional, technical, ecological, or resource conditions after conversion has occurred.

Definition 22.263 (Conversion recoverability profile). A *conversion recoverability profile* records which source dimensions can be restored, by what process, at what

cost and delay, for which positions, under what conditions, and with what remaining difference from the pre-conversion state.

Proposition 22.264 (Irreversibility evidence condition). *A claim of conversion irreversibility should identify the source dimensions whose recovery matters and provide evidence that available reverse pathways fail to restore those dimensions within the relevant horizon rather than inferring irreversibility from one-way institutional labeling alone.*

Definition 22.265 (Conversion-induced option foreclosure). *Conversion-induced option foreclosure* is the reduction or elimination of later feasible uses, relations, rights, capabilities, or trajectories that follows from a conversion process and cannot be recovered without materially different conditions.

Proposition 22.266 (Irreversibility-option condition). *Where the principal consequence of conversion is a change in future feasible options, research should represent irreversibility through option foreclosure and recoverability rather than through immediate target value alone.*

Historical evidence is often essential here because recoverability depends on path and timing. The same physical conversion can be reversible early and effectively irreversible after complementary infrastructures, legal rights, habits, or ecological processes have reorganized around the new state.

22.6.6 Conversion Loss

Conversion-loss research identifies source dimensions, rights, capacities, relations, ecological conditions, options, or representational content that become diminished, inaccessible, externalized, or difficult to recover through conversion. Loss is standpoint-sensitive and mechanism-specific. A difference between source and target becomes a researchable loss when the diminished dimension remains materially relevant to an affected position, explanatory claim, normative evaluation, or later generative process.

Definition 22.267 (Conversion-loss profile). *A conversion-loss profile* records the affected source dimensions, loss mechanism, affected positions, timing, reversibility, manifestation, distribution, and evidential basis of losses associated with a specified conversion episode.

Definition 22.268 (Representational conversion loss). *Representational conversion loss* occurs when a conversion interface compresses, excludes, or renders inaccessible source distinctions that remain materially relevant to interpretation, evaluation, rights, allocation, or later conversion.

Definition 22.269 (Relational conversion loss). *Relational conversion loss* occurs when conversion diminishes an economically consequential relation or relational quality, such as trust, reciprocity, autonomy, membership, coordination capacity, or recognized standing.

Definition 22.270 (Conversion-loss incidence). *Conversion-loss incidence* is the distribution of conversion-associated losses across source holders, target recipients, intermediaries, third parties, future positions, and ecological or institutional configurations affected by the process.

Proposition 22.271 (Loss-redistribution distinction). *Research should distinguish conversion loss from redistribution or capture where the relevant value remains*

economically active but changes position, control, recognition, or beneficiary.

Proposition 22.272 (Loss non-aggregation condition). *Qualitatively heterogeneous conversion losses should be aggregated into a common measure only where the commensuration procedure is substantively warranted and the omitted remainder does not materially alter interpretation.*

A loss profile permits multiple dimensions to remain visible even when one is monetized locally. For example, compensation can estimate a financial burden while a separate record preserves ecological, relational, institutional, or option losses that the compensation measure does not represent.

22.6.7 Conversion Gain

Conversion-gain research studies new or amplified value-bearing conditions generated through the conversion process. Gain can arise because conversion combines complementary inputs, opens institutional access, creates new coordination possibilities, extends recognition, reduces uncertainty, enables learning, or changes the future option set. The target condition therefore need not be interpreted as a conserved amount of source value expressed in another unit.

Definition 22.273 (Conversion-generated gain). *A conversion-generated gain is an economically relevant target-side or system-level value-bearing condition that arises through the conversion process and cannot be adequately characterized as a mere relabeling or positional transfer of the identified source condition.*

Definition 22.274 (Conversion amplification gain). *A conversion amplification gain is an increase in target realization produced when the interface or complementary conditions enhance the effect of a given source condition beyond the response observed under a relevant comparison configuration.*

Definition 22.275 (Conversion co-production). *Conversion co-production occurs when target value is jointly generated by the source condition, conversion interface, complementary resources, affected-party participation, and contextual conditions such that attribution to the source alone would materially misstate the mechanism.*

Proposition 22.276 (Gain attribution condition). *A conversion-gain claim should specify which part of the observed target change is plausibly attributable to the conversion process and which part depends on complementary generation, redistribution, broader environmental change, or measurement revision.*

Definition 22.277 (Conversion-gain incidence). *Conversion-gain incidence is the distribution of conversion-generated benefits, capacities, rights, options, or other target-side gains across positions affected by the conversion architecture.*

Proposition 22.278 (Gain-loss coexistence condition). *The presence of conversion gain does not resolve conversion loss; research should record gain and loss separately where they affect different value forms, positions, or temporal horizons.*

This separation is important for policy and institutional evaluation. A conversion can generate substantial target-side capability while also degrading a source relation or ecological condition. A positive aggregate metric can coexist with concentrated loss or future option foreclosure.

22.6.8 Failed Conversion

Failed-conversion research treats unsuccessful attempts as informative evidence about conversion architecture. Failure can arise because the interface rejects the source, a required condition is absent, the target is realized only symbolically, complementary resources are missing, the process is interrupted, the target is captured by another position, or the original source–target mechanism was incorrectly specified. Distinguishing failure modes turns negative outcomes into mechanism evidence.

Definition 22.279 (Conversion attempt). A *conversion attempt* is a bounded episode in which actors or institutions engage a specified interface with the aim or institutional function of realizing a defined target value form from an identified source condition.

Definition 22.280 (Conversion failure). A *conversion failure* occurs when a conversion attempt does not realize the target condition to the threshold or form specified by the research design, after accounting for the applicable interface and condition set.

Definition 22.281 (Conversion-failure mode). A *conversion-failure mode* is the mechanism through which an attempted conversion fails, such as ineligibility, validation failure, capacity constraint, complementary-resource absence, sequence disruption, target non-realization, symbolic substitution, capture, or source–target misspecification.

Proposition 22.282 (Failure-mode differentiation condition). *Research should distinguish materially different failure modes because interventions that address one failure mechanism can leave another unchanged or intensify it.*

Definition 22.283 (False conversion success). A *false conversion success* is a case in which an interface records formal, symbolic, or administrative completion while the target value-bearing condition specified by the research question remains materially unrealized.

A credential can be issued without producing effective occupational access; compensation can be paid without restoring capability; a platform can report monetization eligibility while meaningful income remains inaccessible. These cases make manifestation and target realization separate empirical objects.

Definition 22.284 (Conversion-failure registry). A *conversion-failure registry* is a structured record of attempted conversions, failure modes, affected positions, conditions, interface stages, observed consequences, and subsequent revisions to the proposed conversion mechanism.

Proposition 22.285 (Negative-evidence integration condition). *A cumulative conversion research programme should retain failed and false-success cases as evidence capable of revising the conversion interface, condition set, rate model, and source–target specification.*

22.6.9 Power over Conversion

Power-over-conversion research examines how control of interfaces, classifications, access conditions, sequencing, pricing, recognition, validation, and alternative pathways changes who can convert value, on what terms, with what burdens, and toward which target forms. The research object is therefore relational. An actor can possess substantial source value while remaining dependent on another position that

controls the interface through which the source becomes actionable.

Definition 22.286 (Conversion power). *Conversion power* is the relational capacity of a position to alter the feasibility, terms, timing, target form, recognition, burden, or incidence of another position's value conversion through control or influence over a materially relevant conversion interface or condition.

Definition 22.287 (Conversion gatekeeping). *Conversion gatekeeping* is control over admission to, validation within, or successful passage through a conversion interface in a manner that materially affects target realization.

Definition 22.288 (Conversion terms-setting power). *Conversion terms-setting power* is the capacity to determine prices, documentation, eligibility thresholds, classifications, timing, contractual conditions, interoperability requirements, evidential standards, or other terms governing a conversion process.

Definition 22.289 (Conversion-alternative structure). A *conversion-alternative structure* records the feasible alternative interfaces, exit options, appeal procedures, bypass routes, portability arrangements, and self-provisioning possibilities available to positions subject to a conversion regime.

Proposition 22.290 (Conversion-power dependence condition). *Control over a conversion interface becomes a stronger candidate source of power as affected positions depend more heavily on the target value, face fewer credible alternatives, bear higher switching or contestation costs, and possess less capacity to alter the governing terms.*

Definition 22.291 (Conversion-power incidence). *Conversion-power incidence* is the distribution of gains, losses, delays, exclusions, obligations, risks, and future dependencies associated with the exercise of conversion power across affected positions.

Proposition 22.292 (Interface-neutrality audit). *Where an interface is treated as a neutral technical or administrative mechanism, research should test whether its rules, classifications, or control structure systematically alter conversion feasibility or incidence across positions before accepting that characterization.*

Definition 22.293 (Conversion-regime comparison). A *conversion-regime comparison* compares two or more conversion architectures with respect to source access, enabling conditions, rate structure, nonlinearities, reversibility, loss, gain, failure modes, power distribution, contestability, and target consequences.

Definition 22.294 (Value-conversion research portfolio). A *value-conversion research portfolio* is an organized set of studies that jointly investigate conversion interfaces, condition sets, local rates, nonlinearities, irreversibility, loss, gain, failure, and power across domains while preserving source–target provenance and revisions to the conversion model.

Proposition 22.295 (Portfolio-level conversion discipline). *A cumulative research programme on value conversion should permit revision of source–target specifications, interface boundaries, condition sets, quantitative rate models, and power hypotheses as comparative and negative evidence accumulates, while preserving records of loss, gain, failure, and affected positions that remain material to later circulation research.*

The portfolio perspective closes the section by making conversion a researchable family of mechanisms rather than a metaphor for change. Conversion interfaces can be institutionally redesigned, conversion conditions can be distributed or withheld, conversion rates can vary across positions and regimes, nonlinearities and irreversibilities can alter future options, gain and loss can coexist, failed conversions can reveal hidden requirements, and control over interfaces can become a source of eco-

nomic power. The next section turns from transformation between value forms to *circulation*: how value-bearing conditions, once generated or converted, move through relational pathways, domains, scales, and time, and how those movements produce return, dissipation, capture, or regeneration.

22.7 Research on Value Circulation

The role of this section is to convert GRE's account of value circulation into a research programme concerned with pathways, recurrence, incidence, intermediation, dissipation, capture, regeneration, and justice. The preceding section treated conversion as a typed transformation between already identified value forms. The present section begins after that conversion problem has been specified and asks how value-bearing objects, conditions, capacities, rights, representations, or effects move and recur across relations, domains, scales, and time. Its objective is to identify the empirical units and formal representations required to distinguish one-way transmission from recurrent circulation, return from recirculation, dissipation from conversion loss, capture from ordinary intermediation, and regeneration from simple persistence. The method is plural and mechanism-oriented: longitudinal tracing, network and higher-order analysis, accounting, institutional analysis, ethnography, archival reconstruction, process tracing, comparative research, and formal models can each be appropriate where their assumptions match the circulation process under study.

Circulation should not be treated as movement of a conserved homogeneous substance. Financial claims, knowledge, care, capabilities, institutional standing, ecological conditions, recognition, and future options can travel through different channels, undergo conversion, branch across recipients, be replicated, disappear from observation, accumulate at bottlenecks, return toward prior positions, or participate in the production of later value. Research on circulation therefore requires typed provenance: the analyst should specify what is circulating, through which relation, with what transformation, to which affected positions, over what horizon, and under whose control whenever those distinctions materially affect the claim.

Definition 22.296 (Value-circulation research object). A *value-circulation research object* is a provisionally bounded set of transmission, transfer, conversion, return, recurrence, dissipation, capture, or regenerative processes through which one or more value-bearing forms become consequential across multiple positions or times while preserving enough provenance to reconstruct the relevant pathways and incidence.

Definition 22.297 (Circulation episode). A *circulation episode* is an empirically delimited sequence or configuration of value-bearing movements and transformations specified by its source and affected positions, value forms, channels, intermediaries, temporal interval, scale, governing conditions, and observable or reconstructable consequences.

Proposition 22.298 (Circulation provenance condition). *Research on value circulation should preserve the distinctions required to separate transmission, transfer, conversion, recurrence, return, dissipation, capture, and regeneration whenever collapsing those processes would materially alter the explanation or evaluation.*

Table 22.7 summarizes the twelve research domains developed in this section.

Table 22.7: Principal research domains in value circulation

Research domain	Primary object	Characteristic evidence	Principal research burden
Relational pathways	Ordered and branching paths through which value becomes effective	Transaction, communication, logistics, organizational, legal, and process records	Reconstruct pathways without assuming neutral channels
Cross-domain circulation	Movement across institutional or functional domains	Linked records, interface rules, multi-domain case histories, conversion evidence	Preserve changes of meaning and value form across domains
Cross-scale circulation	Local, organizational, sectoral, national, transnational, or ecological coupling	Multilevel data, network structure, policy chains, nested cases	Identify coupling mechanisms rather than infer scale effects from size
Temporal circulation	Delay, recurrence, persistence, latency, and sequencing	Longitudinal data, event histories, archives, repeated observations	Match temporal horizon to the mechanism and identify delayed incidence
Return flows	Backward or source-oriented pathways	Revenue return, feedback, maintenance, knowledge return, remittances, ecological replenishment	Distinguish return from reciprocity, compensation, and later independent generation
Recirculation	Recurrent cycles that modify later generation or transmission	Repeated-cycle data, reinvestment records, recurrent interaction, stock-flow histories	Demonstrate more than one consequential iteration
Dissipation	Attenuation, disappearance, degradation, or loss of effective availability	Leakage, decay, attrition, abandonment, degradation, expiry, non-use	Distinguish dissipation from measurement failure and intentional consumption
Capture	Retention or control of value along a pathway	Fees, rents, commissions, rights, gatekeeping, ownership, appropriation records	Separate necessary mediation from capture and locate incidence
Regeneration	Renewal or expansion of circulation-supporting capacity	Replenishment, maintenance, learning, ecological renewal, capability formation	Identify the mechanism linking circulating value to renewed capacity
Transmission formalisms	Typed paths, kernels, networks, hypergraphs, trajectories, or event structures	Formal representations linked to empirically identified states and channels	Preserve types, provenance, scale, and transformation without false conservation
Transfer incidence	Direct and indirect consequences across recipients and intermediaries	Administrative data, accounting, surveys, process tracing, affected-party evidence	Extend beyond formal sender and recipient where mediation changes incidence
Transmission justice	Recognition, participation, burden, control, return, and future option effects	Governance rules, participation records, burden data, contestation, distributive evidence	Keep descriptive transmission architecture distinct from normative judgment

22.7.1 Relational Pathways

Relational-pathway research reconstructs the channels and sequences through which value-bearing conditions become effective elsewhere. A pathway can be contractual, organizational, technical, legal, communicative, financial, logistical, ecological, interpersonal, or composed from several of these at once. The research object is the path as an economically consequential relation structure rather than as a neutral conduit. Channels can validate, filter, translate, delay, amplify, attenuate, condition, or redirect what passes through them.

Definition 22.299 (Circulation pathway). A *circulation pathway* is an ordered or partially ordered sequence of relational channels and positions through which a specified value-bearing object, condition, representation, capacity, right, or effect becomes available, transformed, redistributed, or consequential over a stated horizon.

Definition 22.300 (Pathway provenance record). A *pathway provenance record* identifies the value form at each analytically material stage, the positions involved, relevant transformations, timing, governing rules, and evidential basis for reconstructing

a circulation pathway.

Pathways can branch. Knowledge may be transmitted to several recipients without disappearance from the source; a public investment can create material, institutional, capability, and option effects through different downstream branches; a payment can be divided across workers, creditors, platforms, taxes, savings, and suppliers. A simple dyadic representation can therefore understate both reach and incidence.

Proposition 22.301 (Path expansion condition). *A circulation analysis should expand beyond a sender–recipient dyad when branching, intermediation, transformation, or downstream affected positions materially changes the explanatory or evaluative conclusion.*

Research should also preserve channel substitution. Two pathways can deliver formally similar outputs while differing in delay, burden, contestability, dependency, privacy, ecological consequence, or later options. Comparative analysis should therefore distinguish outcome equivalence from pathway equivalence.

Definition 22.302 (Pathway substitutability profile). *A pathway substitutability profile records which functions and consequences are preserved when one circulation pathway is replaced by another, together with differences in timing, burden, value form, control, reliability, and later generative conditions.*

Proposition 22.303 (Pathway non-neutrality). *Where channel structure changes transformation, incidence, dependency, delay, burden, or later opportunity, equivalent nominal receipt does not establish equivalent circulation.*

22.7.2 Cross-Domain Circulation

Cross-domain circulation studies trajectories that traverse institutional or functional domains whose categories, rules, and value manifestations differ. Examples can include knowledge becoming a credential, ecological restoration entering a tourism economy, care work affecting labor-market participation, data becoming organizational control, or community reputation influencing access to finance. The research problem is to reconstruct how value-bearing conditions travel through interfaces without presuming that meaning or measurement remains invariant.

Definition 22.304 (Circulation domain). *A circulation domain is a provisionally bounded institutional, organizational, legal, technical, ecological, cultural, or practical field within which a specified value form is recognized, produced, transmitted, or evaluated under sufficiently coherent rules for analysis.*

Definition 22.305 (Cross-domain circulation episode). *A cross-domain circulation episode is a circulation episode that crosses at least one analytically material domain boundary and therefore requires explicit reconstruction of the interface through which value becomes legible or effective in the receiving domain.*

Domain crossing can occur with or without conversion. A legal right may travel across organizations while retaining its type; a research result can circulate from academia into policy through translation and certification; a financial grant can enable epistemic or capability value without those forms becoming financially commensurate. The empirical task is to identify the interface and its effect on what survives the transition.

Proposition 22.306 (Domain-boundary preservation condition). *Cross-domain circulation should preserve the source and receiving domain rules required to determine*

whether the observed process is transmission of the same value form, conversion between forms, institutional recognition, reclassification, or co-generation.

A further research object is domain privilege. Some domains possess greater capacity to define which manifestations count as valid inputs for others. Financial valuation, legal recognition, accreditation, and algorithmic classification can become gateway regimes through which heterogeneous value must pass before becoming actionable elsewhere.

Definition 22.307 (Domain-gateway position). *A domain-gateway position is a position or institution whose recognition, classification, authorization, or representation materially conditions whether value generated in one domain can become effective in another.*

Proposition 22.308 (Gateway asymmetry condition). *Where one domain systematically controls access to another, circulation research should examine the resulting asymmetry in recognition, conversion burden, delay, exclusion, and capacity to contest the gateway.*

22.7.3 Cross-Scale Circulation

Cross-scale circulation research examines how value-bearing processes couple local, organizational, sectoral, regional, national, transnational, and ecological scales. Scale should be treated as an analytical property of the mechanism rather than as a fixed hierarchy. A process can originate locally and propagate through standards or networks, while a global rule can reshape local opportunities through institutional and technical interfaces.

Definition 22.309 (Scale-coupling mechanism). *A scale-coupling mechanism is an empirically defensible process through which circulation at one analytical scale changes the availability, transformation, incidence, or governance of value at another scale.*

Definition 22.310 (Cross-scale circulation profile). *A cross-scale circulation profile records the initiating scale, receiving scales, coupling mechanisms, intermediaries, delays, amplification or attenuation, affected positions, and scale-specific manifestations of a circulation episode.*

Cross-scale inference requires caution. A successful local cooperative practice need not scale through replication if its operation depends on dense trust or tacit knowledge. A national funding programme can have weak local incidence where conversion infrastructure is absent. Conversely, a small standard-setting body can reshape large systems when compliance becomes widely embedded.

Proposition 22.311 (Cross-scale mechanism condition). *Evidence of outcomes at multiple scales supports a cross-scale circulation claim only where a plausible coupling mechanism links those outcomes and materially improves explanation over parallel or common-cause accounts.*

Definition 22.312 (Scale attenuation). *Scale attenuation is a reduction in effective circulation as a process crosses scale because of capacity limits, institutional mismatch, coordination loss, translation burden, local resistance, congestion, or another specified mechanism.*

Definition 22.313 (Scale amplification). *Scale amplification is an increase in reach or consequence across scale through replication, network reinforcement, standardization, institutional authority, complementarity, shared infrastructure, or another*

specified mechanism.

22.7.4 Temporal Circulation

Temporal-circulation research studies delay, recurrence, persistence, latency, sequencing, and temporal mismatch among value processes. Immediate transfer records can conceal long-horizon capability effects, maintenance burdens, ecological consequences, institutional learning, or option changes. The appropriate temporal boundary should therefore be selected according to the mechanism rather than according to administrative reporting intervals.

Definition 22.314 (Circulation horizon). A *circulation horizon* is the temporal interval over which a circulation claim is evaluated, chosen to capture the mechanism and consequences material to the research question.

Definition 22.315 (Circulation latency). *Circulation latency* is the interval between an initiating transmission or transfer and the point at which a specified downstream value effect becomes observable, effective, or reconstructable.

Definition 22.316 (Temporal incidence profile). A *temporal incidence profile* records when benefits, burdens, rights, maintenance obligations, capability effects, losses, and future-option consequences associated with a circulation episode arise across affected positions.

Research designs should distinguish delay from persistence. A delayed effect can be brief once realized, while an immediate effect can persist for decades through institutional or infrastructural lock-in. Similarly, recurrence differs from persistence: repeated transfers can occur without durable change, and durable institutions can persist without repeated flows.

Proposition 22.317 (Temporal decomposition condition). *Where timing materially affects interpretation, circulation research should distinguish initiation, latency, realization, persistence, recurrence, and termination rather than compressing them into one before-after interval.*

Proposition 22.318 (Horizon sensitivity). *A conclusion about the incidence or effectiveness of circulation should be treated as horizon-sensitive when materially different benefits, burdens, or option effects emerge under defensible alternative time horizons.*

22.7.5 Return Flows

Return-flow research identifies pathways through which value-bearing conditions move toward earlier source positions, contributors, maintaining infrastructures, or other positions connected to prior generation. The term is descriptive at this stage. A return can be monetary, epistemic, relational, institutional, ecological, material, participatory, or capability-related, and it does not by itself establish reciprocity, fairness, regeneration, or generative adequacy. Those stronger interpretations require additional evidence.

Definition 22.319 (Return flow). A *return flow* is a circulation pathway whose direction or functional incidence brings a value-bearing object, condition, capacity, right, representation, or consequence toward a position materially connected to an earlier source, contribution, enabling condition, or maintenance function.

Definition 22.320 (Return-flow provenance). *Return-flow provenance* records the earlier generative or enabling relation to which a return is attributed, the returned value form, pathway, intermediary structure, delay, incidence, and evidential basis for linking the return to that prior relation.

A dividend, royalty, remittance, research feedback loop, community reinvestment, maintenance contribution, ecological nutrient return, or knowledge contribution can each instantiate a return pathway under different conditions. The analytical task is to avoid interpreting directional movement alone as a meaningful return. A payment to a nominal source can coexist with depletion of the relations or capacities that actually generated the value.

Proposition 22.321 (Return attribution condition). *A return-flow claim should identify the prior source or enabling relation to which the flow is attributed and provide evidence that the returning value is materially connected to that relation rather than merely coincident with it.*

Definition 22.322 (Return mismatch). *A return mismatch* occurs when the formal recipient or nominal destination of a return differs materially from the positions, relations, infrastructures, or ecological conditions that generated or maintained the relevant value process.

Proposition 22.323 (Descriptive return boundary). *Evidence of a return flow establishes neither adequate generative return nor justice of return; those stronger claims require separate analysis of maintenance, regeneration, contribution, affected positions, governance, and future generative capacity.*

22.7.6 Recirculation

Recirculation research studies recurrent value pathways in which prior circulation alters the conditions of later generation, transmission, conversion, or circulation. Recirculation therefore requires more than repeated payment or repeated exchange. The return or recurrent flow must enter a subsequent cycle in a way that changes the capacity, relation, infrastructure, rule, or resource condition relevant to later activity.

Definition 22.324 (Recirculation cycle). *A recirculation cycle* is a sequence in which value-bearing effects produced or transmitted during one circulation episode re-enter a later episode and materially affect the conditions of subsequent generation, conversion, transmission, or circulation.

Definition 22.325 (Recirculation depth). *Recirculation depth* is the number of empirically distinguishable iterations through which returned or recurrent value continues to alter later circulation conditions within the stated research horizon.

Proposition 22.326 (Recirculation evidence condition). *A recirculation claim should identify at least one consequential later iteration in which prior circulation changes the conditions of subsequent activity, rather than inferring recirculation from periodic recurrence alone.*

Recirculation can strengthen or weaken later capacity. Community procurement can retain resources and support local capabilities; a platform's commission revenue can finance infrastructure that increases later transaction volume; repeated extraction can deplete a source and reduce future circulation; knowledge sharing can expand a commons that increases later innovation. The sign of the effect should therefore remain an empirical question.

Definition 22.327 (Recirculation effect profile). A *recirculation effect profile* records how a recurrent flow changes later capacity, participation, relation quality, infrastructure, ecological condition, option space, or governance across successive iterations.

Proposition 22.328 (Recirculation valence neutrality). *The existence of recirculation does not establish beneficial regeneration: recurrent flows can reinforce productive capacity, reproduce dependence, accelerate depletion, stabilize exclusion, or have mixed effects across positions.*

22.7.7 Dissipation

Dissipation research examines processes through which value-bearing effects attenuate, degrade, expire, fragment, become inaccessible, or cease to produce the consequences required by the circulation claim. Dissipation differs from conversion loss. Conversion loss concerns what is diminished through a specified transformation between value forms, whereas dissipation can occur during circulation even without a change of value form.

Definition 22.329 (Circulation dissipation). *Circulation dissipation* is the mechanism-specific reduction in effective availability, intensity, usability, recognition, reach, persistence, or consequentiality of a value-bearing condition as it moves or recurs through a circulation pathway.

Definition 22.330 (Dissipation profile). A *dissipation profile* records the stage, mechanism, affected value dimension, affected positions, temporal pattern, recoverability, and evidential basis of attenuation within a circulation pathway.

Dissipation can arise through fees, friction, decay, forgetting, obsolescence, loss of trust, ecological degradation, data-quality deterioration, institutional exclusion, coordination breakdown, expiry, or non-use. Yet apparent disappearance can also result from measurement failure or migration into an unobserved value form. Research should therefore distinguish substantive dissipation from observational loss.

Proposition 22.331 (Dissipation identification condition). *A dissipation claim should identify a mechanism reducing effective circulation and examine whether apparent attenuation can instead be explained by measurement failure, delayed realization, conversion, displacement, or movement beyond the chosen observation boundary.*

Definition 22.332 (Dissipation destination). A *dissipation destination* is the empirically relevant state into which a previously effective value-bearing condition passes when it ceases to support the circulation outcome under study, including degradation, abandonment, externalization, inaccessible storage, or another specified state.

Proposition 22.333 (Dissipation-boundary sensitivity). *A circulation loss should be classified as dissipation only relative to a stated analytical boundary and mechanism; value that leaves one pathway can remain effective elsewhere.*

22.7.8 Capture

Capture research examines retention, appropriation, diversion, or control of value at positions along a circulation pathway. Capture is descriptive before normative evaluation. Fees, taxes, rents, licensing payments, margins, commissions, data appropriation, or institutional retention can each represent captured portions or controls rel-

ative to a specified pathway while differing substantially in contribution, legitimacy, public purpose, and distributive consequence.

Definition 22.334 (Circulation capture). *Circulation capture* is the retention, appropriation, diversion, or control of a value-bearing flow or downstream consequence by a position whose relation to generation, mediation, governance, or entitlement is analytically separable from the captured value itself.

Definition 22.335 (Capture point). A *capture point* is a position, interface, rule, or institutional arrangement at which part of a circulation process can be retained, redirected, conditioned, priced, withheld, or appropriated.

Definition 22.336 (Capture profile). A *capture profile* records the captured value form, capture point, mechanism, claimant position, contribution or mediation role, governing entitlement, affected positions, alternatives, contestability, and downstream effects.

Research should distinguish capture from compensation for necessary mediation. An intermediary can contribute coordination, verification, infrastructure, risk bearing, translation, or maintenance. A capture analysis becomes informative when it separates those functions from control-based retention and asks how alternatives, bargaining conditions, and governance shape the resulting share or control.

Proposition 22.337 (Capture-mediation decomposition). *Where an intermediary both contributes to circulation and retains part of its value, analysis should separate the empirically supported mediation function from the additional retention, control, or appropriation attributed to capture.*

Definition 22.338 (Cumulative capture). *Cumulative capture* occurs when repeated control over circulation pathways enables a position to accumulate resources, rights, information, or bargaining advantages that strengthen its capacity to capture later flows.

Proposition 22.339 (Capture feedback condition). *Claims of cumulative capture require evidence that prior capture changes later control or bargaining conditions rather than merely showing repeated retention at a stable rate.*

22.7.9 Regeneration

Regeneration research studies processes through which circulation renews or expands the conditions required for later value generation and circulation. Regeneration differs from persistence: a system can persist by consuming inherited stocks, and a circulating flow can recur while degrading the conditions on which it depends. Regeneration therefore requires evidence of replenishment, repair, learning, renewal, or capacity formation.

Definition 22.340 (Circulation-supported regeneration). *Circulation-supported regeneration* is a process in which value moving through or returning within a circulation system materially renews, repairs, expands, or diversifies the capacities, relations, infrastructures, ecological conditions, or option spaces required for later value generation or circulation.

Definition 22.341 (Regenerative target). A *regenerative target* is the capacity, relation, infrastructure, ecological condition, institution, knowledge base, or option structure whose renewal is claimed to result from circulation.

Proposition 22.342 (Regeneration evidence condition). *A regeneration claim should*

identify the regenerative target, the circulation pathway supplying relevant inputs, and evidence that the target's later functional or generative capacity has been renewed or expanded relative to an appropriate baseline.

Regeneration can be partial and uneven. A financial surplus can renew physical infrastructure while exhausting labor relations; knowledge circulation can strengthen technical capacity while weakening local autonomy; ecological restoration can improve one service while reducing another. A non-scalar profile is therefore often preferable to an aggregate regenerative score.

Definition 22.343 (Regeneration profile). *A regeneration profile records the renewed and depleted dimensions associated with a circulation process, affected positions, temporal horizon, reversibility, evidence, and remaining uncertainty.*

Proposition 22.344 (Regeneration non-equivalence). *Evidence that circulation regenerates one valued capacity does not establish overall regenerative adequacy where other materially relevant capacities, relations, or ecological conditions deteriorate.*

22.7.10 Value-Transmission Formalisms

Formal research on circulation can clarify pathway structure, type changes, recurrence, timing, and incidence when the empirical object supports explicit representation. The formalism should remain subordinate to the research question. Networks can represent pairwise channels, hypergraphs can represent group-dependent transmission, event structures can preserve partial temporal order, kernels can represent stochastic transitions, and trajectory models can preserve path history. No single representation should be treated as the ontology of circulation.

A minimal typed representation can begin with a set of positions P , a set of value types V , a set of circulation channels E , and a set of context states C . Each channel $e \in E$ has a source position $s(e) \in P$, a target position $t(e) \in P$, an admissible source value type $a(e) \in V$, an output value type $b(e) \in V$, and a context-dependent transition rule. Where a probabilistic representation is justified, the local transition kernel is stated in Equation 22.1.

$$K_e^{a \rightarrow b}(y \mid x, c, \Delta t) = \Pr(Y_{b,t+\Delta t} = y \mid X_{a,t} = x, C_t = c, e). \quad (22.1)$$

Equation 22.1 is a local representation rather than a universal conversion law. Its variables can be scalar, vector, categorical, ordinal, set-valued, or otherwise typed according to the empirical object, and a kernel is inappropriate where the states cannot be defensibly represented probabilistically.

Definition 22.345 (Typed circulation system). *A typed circulation system is a formal representation $\mathcal{C} = (P, V, E, C, \mathcal{K})$ whose components identify positions, value types, channels, context states, and the family $\mathcal{K}$ of empirically warranted transition rules required by the circulation question.*

For an ordered pathway $\pi = (e_1, \dots, e_m)$ whose adjacent types are compatible, the path-level transformation can be represented by composition of the local transition rules. Equation 22.2 states the structural relation without assuming that the intermediate value forms share a common metric.

$$K_\pi = K_{e_m} \circ K_{e_{m-1}} \circ \dots \circ K_{e_1}. \quad (22.2)$$

Equation 22.2 should be interpreted only where composition preserves the empirically relevant intermediate states. If an intermediate transformation creates path-dependent memory, a state variable or history-bearing representation must be added rather than hidden inside a memoryless composition.

Definition 22.346 (Circulation path memory). *Circulation path memory* is any empirically material dependence of later transmission on prior pathway history that cannot be represented adequately by the current local state alone.

Proposition 22.347 (History-sensitive formalism condition). *Where prior pathway history changes later transition possibilities, a formal circulation model should include the required history-bearing state or trajectory structure rather than impose a memoryless representation for convenience.*

Recurrence can be represented by cycles in a graph only when the repeated edge structure corresponds to an empirically meaningful repeated process. Apparent topological cycles can otherwise conceal transformed conditions, changing actors, or irreversible history.

Definition 22.348 (Empirical circulation cycle). An *empirical circulation cycle* is a formally represented recurrent path whose repeated traversal corresponds to distinguishable circulation episodes with sufficient continuity of mechanism and state meaning for comparison across iterations.

Proposition 22.349 (Formal restraint in circulation). *A circulation formalism earns analytical use only to the extent that its nodes, channels, types, transformations, temporal assumptions, and observables can be connected to evidence or explicitly identified as heuristic abstractions.*

22.7.11 Transfer Incidence and Intermediation

Transfer-incidence research asks who or what is materially affected by a circulation process beyond the formal sender and recipient. Intermediation can change fees, delay, eligibility, information, risk, recognition, burden, bargaining position, and later options. A transfer that is complete in accounting terms can therefore have an incidence architecture extending well beyond the recorded transaction.

Definition 22.350 (Transfer-incidence architecture). A *transfer-incidence architecture* records the direct recipient, source, intermediaries, indirect beneficiaries, burden bearers, excluded positions, maintenance contributors, downstream affected parties, and temporal or scale-specific consequences materially associated with a transfer or transmission process.

Definition 22.351 (Intermediary function profile). An *intermediary function profile* records the coordination, verification, translation, aggregation, storage, matching, financing, risk-bearing, gatekeeping, classification, monitoring, or other functions performed by an intermediary, together with associated burdens, rights, compensation, and control.

Intermediaries can create value while also acquiring power over the terms of circulation. Their analysis should therefore avoid both assumptions that intermediation is friction and assumptions that existing intermediaries are necessary because they are observed. Comparative research can examine alternative institutional arrangements that preserve useful functions while changing control or incidence.

Proposition 22.352 (Intermediation counterfactual condition). *Claims about the ne-*

cessity, efficiency, or burden of an intermediary should be evaluated against plausible alternative arrangements that perform comparable functions under the relevant domain conditions.

Definition 22.353 (Incidence displacement). *Incidence displacement* occurs when the position formally assigned a benefit or burden differs materially from the position that ultimately realizes, finances, maintains, absorbs, or bears it through the circulation pathway.

Proposition 22.354 (Extended incidence condition). *Where intermediation, externalization, delayed effects, or conversion conditions materially shift benefits or burdens, evaluation limited to formal transfer endpoints is inadequate for the stated research claim.*

Transfer incidence can also be epistemically asymmetric. Intermediaries often possess better data on pathway structure, pricing, selection, or downstream effects than sources or recipients. Access to those records becomes part of the research infrastructure required to test claims about capture, efficiency, fairness, or regeneration.

Definition 22.355 (Incidence observability gap). An *incidence observability gap* is a material difference between the affected positions or consequences relevant to a transfer claim and the positions or consequences observable through available records.

22.7.12 Justice of Transmission and Transfer

Justice research on transmission and transfer evaluates the terms through which value moves, transforms, returns, dissipates, or becomes captured. Its objects include recognition of contribution, participation in channel governance, burdens of maintenance, dependence, exit, contestability, return, downstream incidence, and consequences for future capabilities. The section remains theory-plural: these objects can be evaluated through different normative traditions, and GRE does not turn circulation analysis into one universal distributive rule.

Definition 22.356 (Transmission-justice profile). A *transmission-justice profile* records the justice-relevant source, recipient, intermediary, generator, maintainer, and affected positions; the value forms and channels involved; contribution and recognition; participation and consent; burdens and risks; dependency and exit; contestability; return; capture; and consequences for future agency or generative conditions.

Definition 22.357 (Transmission burden). A *transmission burden* is a cost, risk, maintenance requirement, loss of autonomy, ecological consequence, informational exposure, dependency, or other materially adverse condition borne by a position because of its location within a circulation pathway.

A justice analysis should not assume that equal nominal transfer implies equal benefit. Different conversion conditions can produce unequal effective incidence. Nor should it assume that return to a formal owner satisfies reciprocity where generative contributors, maintainers, communities, infrastructures, or ecological systems remain depleted. The relevant normative objects depend on the theory of justice being applied and the empirical architecture of the pathway.

Proposition 22.358 (Justice-incidence condition). *Where a transmission materially changes recognition, participation, burden, dependency, exit, contestability, capture, re-*

turn, or future agency, justice analysis should include those relational effects in addition to nominal transfer amounts or formal rights.

Definition 22.359 (Transmission contestability). *Transmission contestability* is the effective capacity of materially affected positions to question, challenge, refuse, appeal, renegotiate, audit, or seek revision of the rules and outcomes governing a circulation pathway.

Proposition 22.360 (Contestability evidence condition). *The existence of a formal complaint or appeal mechanism establishes effective contestability only where materially affected positions can access it, obtain relevant information, and plausibly secure review or remedy without prohibitive burden.*

Intergenerational and ecological incidence also complicate justice. Future positions can inherit debt, infrastructure, knowledge, standards, depleted resources, restored ecosystems, or institutional capacities without having participated in the initiating transfer. Circulation research should therefore preserve temporal and scale-specific incidence where these effects are material.

Definition 22.361 (Intertemporal transmission-justice record). *An intertemporal transmission-justice record* identifies materially affected present and future positions, the transmitted benefits and burdens, relevant option effects, maintenance requirements, irreversibilities, and uncertainties required for normative evaluation over time.

The section closes with a boundary principle. Descriptive circulation research can identify pathways, recurrence, return, dissipation, capture, regeneration, and incidence. Normative evaluation requires additional principles concerning entitlement, contribution, equality, capability, recognition, autonomy, sustainability, reciprocity, repair, or another justified criterion. Keeping the two levels distinct allows evidence about circulation to inform justice without making observed circulation patterns self-validating.

Proposition 22.362 (Circulation research boundary). *A GRE circulation study is analytically adequate when it preserves the pathways, value types, transformations, temporal and scalar incidence, intermediary functions, and control relations material to the claim while stating which questions of generative return, power, and justice require additional theory or evidence.*

The immediate next research problem concerns one of those stronger questions. Return flows and recirculation can be described without establishing whether value returns to the relations, communities, knowledge systems, capabilities, or future-option structures whose renewal sustains generation. The next section therefore isolates *generative return* as a distinct research object.

22.8 Research on Generative Return

The role of this section is to convert GRE's concept of generative return into a research programme capable of distinguishing descriptive return flows from returns that renew the conditions of later generation. A payment, recognition, data flow, institutional response, or material transfer can move toward an earlier source without restoring the relations, capabilities, knowledge systems, infrastructures, ecological conditions, or practical option structures through which value was generated. The research object is therefore recursive and historical: an earlier generative process

produces value-bearing effects, some of those effects later re-enter a materially connected configuration, and the inquiry asks whether that re-entry changes the capacity for subsequent generation. The section's objective is to specify units of analysis, attribution requirements, temporal boundaries, equivalence conditions, and justice questions for such claims. The discussion proceeds through source relations, communities, knowledge systems, capabilities, future options, equivalence and non-equivalence, delay, and justice. The method is plural and mechanism-oriented. Longitudinal analysis, process tracing, institutional and organizational analysis, ethnography, archival reconstruction, accounting, capability assessment, network or higher-order representation, comparative research, and formal modelling can each be appropriate when they preserve the mechanism and uncertainty material to the claim.

The distinction from value circulation is substantive. Circulation research can establish that value returns toward an earlier contributor, institution, place, or domain. Generative-return research adds a stronger question: does the returned condition actually renew, preserve, repair, expand, diversify, or otherwise sustain a specified capacity for later generation? The relevant target may be a relation rather than an entity, and the returned value may differ in type from the value originally produced. Attribution also remains distributed. A later regenerative effect can depend on many contributors, infrastructures, institutions, and historical conditions, so evidence of return rarely warrants exclusive causal ownership.

Definition 22.363 (Generative-return research object). *A generative-return research object is a provisionally bounded relation among an originating generative process, a returned value-bearing condition, a regenerative target, a re-entry pathway, affected positions, and a time horizon, studied to determine whether the returned condition materially changes later generative capacity.*

Definition 22.364 (Generative-return episode). *A generative-return episode is an empirically reconstructable episode in which a value-bearing effect attributable with stated evidential standing to an earlier process re-enters a later configuration and contributes to renewal, preservation, repair, expansion, diversification, or transformation of a specified generative target.*

Proposition 22.365 (Generative-return evidence condition). *A claim of generative return should identify the originating process, returned condition, regenerative target, re-entry pathway, affected positions, temporal horizon, comparison baseline, and plausible rival explanations at the level required by the inquiry.*

The comparison baseline matters because persistence can be mistaken for renewal. Avoided deterioration can constitute generative return, but the claim should be stated as preservation or repair. A return can also strengthen one target while weakening another, so a non-scalar profile is often more informative than a single return score.

Table 22.8 summarizes the principal research domains developed in this section.

Definition 22.366 (Generative-return profile). *A generative-return profile records the regenerative targets strengthened, preserved, repaired, diversified, or weakened by a return process; the value forms involved; affected positions; timing; pathway; control structure; uncertainty; and evidence supporting each dimension.*

Proposition 22.367 (Return-profile non-aggregation). *Where generative-return dimensions are heterogeneous or partly incommensurable, evidence of strong return in one dimension does not establish overall return adequacy across the remaining materially relevant dimensions.*

Table 22.8: Principal research domains in generative return

Research domain	Primary object	Principal evidential burden
Source relations	Relations and infrastructures implicated in prior generation	Trace contribution, maintenance, depletion, re-entry, and subsequent relational capacity
Communities	Collective and place-based generative conditions	Specify community boundaries, internal incidence, governance, reproduction, and asymmetry
Knowledge systems	Knowledge, epistemic infrastructure, and inquiry capacity	Reconstruct provenance, reuse, maintenance, accessibility, learning, and later knowledge generation
Capabilities	Individual and collective effective abilities	Distinguish nominal resources from realized capability renewal and later practical use
Future options	Reachable and generatable future possibilities	Identify preserved or created option structures, enabling conditions, and foreclosure effects
Equivalence	Relation between contributed and returned value	State the signature under which substitution, replenishment, or non-equivalence is claimed
Delay	Latency, maturation, maintenance, and historical mediation	Preserve causal provenance across long horizons and changing conditions
Justice	Entitlement, contribution, affectedness, burden, governance, and repair	Separate descriptive return adequacy from justified principles of who should receive, control, or govern return

22.8.1 Source-Relation Return

Source-relation return studies whether value returns to the relations and enabling structures through which earlier generation became possible. The source relation may involve labor cooperation, care, trust, infrastructure, ecological dependence, institutional authorization, knowledge sharing, financing, maintenance, or a higher-order configuration among several such relations. The analytical task is therefore different from asking whether an owner, investor, organization, or nominal producer received compensation. An entity can receive substantial return while the relations that sustained production deteriorate.

Definition 22.368 (Generative source relation). A *generative source relation* is a relation or higher-order configuration that made a materially identifiable contribution to the generation, maintenance, transmission, or realization of a value-bearing process under study.

Definition 22.369 (Source-relation return). A *source-relation return* is a generative return whose regenerative target is one or more generative source relations, including the capacities, infrastructures, rules, ecological conditions, or maintenance practices required for those relations to remain generatively effective.

Source attribution should remain mechanism-specific. A supplier relationship can be important because of specialized knowledge, a community relationship because of legitimacy and local coordination, an ecological relation because of material regeneration, and a care relation because it maintains participants' capacity to act. A single

output can therefore have several generative source relations with different types of contribution. Research should preserve that plurality where it materially affects return incidence.

Definition 22.370 (Source-relation attribution record). *A source-relation attribution record identifies the source relations claimed to contribute to a value-generating process, the mechanism of contribution, available evidence, competing attributions, associated maintenance or depletion, and the returned conditions subsequently directed toward those relations.*

Proposition 22.371 (Contribution-return separation). *Evidence that a relation contributed to value generation and evidence that value later returned to that relation are distinct claims and should be supported separately.*

Return adequacy also depends on the state of the source relation. Equal nominal return can have different regenerative effects under different maintenance backlogs, depletion, ecological damage, or institutional fragility. The relevant comparison is therefore with relational renewal requirements.

Definition 22.372 (Relational renewal requirement). *A relational renewal requirement is a condition whose restoration, preservation, or development is materially necessary for a specified generative source relation to sustain or improve the function relevant to the research claim.*

Proposition 22.373 (Source-relation adequacy condition). *A source-relation return is generatively adequate only with respect to a stated target and horizon, and only where the returned condition materially addresses the relevant renewal requirements rather than merely reaching a formally associated entity.*

This perspective also creates a research programme on maintenance. Some generative relations persist because maintenance work, replacement investment, conflict resolution, ecological recovery, training, care, or institutional updating continually renews them. Such work can remain poorly represented when evaluation focuses on gross output. A return analysis can therefore ask whether the circulation architecture replenishes maintenance capacity before visible breakdown occurs.

Definition 22.374 (Generative maintenance deficit). *A generative maintenance deficit is a persistent gap between the maintenance conditions required to sustain a generative source relation and the conditions actually returned or otherwise made available for that maintenance.*

22.8.2 Community Return

Community-return research studies whether economic processes that draw on place-based, cultural, relational, infrastructural, ecological, or collective capacities contribute to the renewal of the communities through which those capacities are generated or maintained. The concept requires careful boundary construction. A community can be territorial, professional, epistemic, cultural, practice-based, or institutionally constituted, and internal interests can diverge sharply. Research should therefore identify who is included in the community claim and how benefits, burdens, voice, and control are distributed internally.

Definition 22.375 (Community-return research object). *A community-return research object is a generative-return configuration in which the regenerative target is a bounded community's materially relevant collective capacities, relations, infras-*

tructures, ecological conditions, institutions, or practical ability to reproduce and transform shared activity.

Definition 22.376 (Community-boundary record). A *community-boundary record* states the membership rule or empirical boundary used in a community-return claim, the basis for that boundary, internal heterogeneity, excluded or adjacent affected positions, and uncertainties or contestation concerning membership.

Community return is broader than local expenditure. Procurement, employment, revenue sharing, public services, infrastructure, knowledge access, land stewardship, institutional participation, and strengthened collective capability can all be relevant, but their generative significance depends on what they renew. Spending that increases short-term consumption can coexist with declining local capability; infrastructure can increase capacity while displacing existing relations; employment can raise income while weakening community control over key assets. The research object is therefore the pattern of regeneration, not a presumed positive valence of localization.

Definition 22.377 (Community regeneration profile). A *community regeneration profile* records the community capacities, relations, infrastructures, ecological conditions, institutions, and option structures strengthened, preserved, transformed, or depleted through a return process, together with internal incidence and governance.

Proposition 22.378 (Community-internal incidence condition). A *community-return claim should preserve materially relevant internal differences in receipt, burden, participation, control, and later capability whenever aggregate community measures would conceal divergent generative effects.*

Governance is especially important because return can be received collectively while controlled narrowly. A community fund, common asset, data repository, or ecological compensation arrangement may have broad formal purpose but concentrated decision authority. Research should distinguish collective destination from collective governance.

Definition 22.379 (Community-return governance profile). A *community-return governance profile* records who defines return priorities, controls returned resources or rights, participates in decision processes, bears implementation burdens, can contest decisions, and receives information required for meaningful oversight.

Proposition 22.380 (Collective-destination non-equivalence). *The formal designation of a return as community-directed does not establish community-level generative return where control, incidence, or renewal of collective capacities remains materially concentrated or absent.*

22.8.3 Knowledge-System Return

Knowledge-system return concerns the renewal of epistemic capacities that made prior knowledge generation possible and that condition future inquiry, interpretation, learning, and application. A research output can circulate widely while the institutions, archives, skills, languages, data infrastructures, communities of practice, or maintenance labor supporting its production deteriorate. Conversely, a project can generate modest immediate output while substantially improving future knowledge-generating capability through training, documentation, shared infrastructure, or reusable methods.

Definition 22.381 (Knowledge-system return). A *knowledge-system return* is a generative return whose target is the epistemic capacity of a knowledge-generating configuration, including people, practices, archives, data, instruments, institutions, languages, interpretive resources, standards, and infrastructures materially required for later inquiry or learning.

Definition 22.382 (Epistemic regenerative target). An *epistemic regenerative target* is a specified component or relation of a knowledge system whose renewal, preservation, repair, diversification, or accessibility is claimed to improve later knowledge generation or use.

Research can examine several return pathways. Knowledge can return through reusable data and software, cumulative documentation, training, mentoring, institutional memory, open infrastructure, replication resources, improved problem formulation, or renewed interpretive capacity. The research design should identify actual reuse or capacity change rather than infer return merely from the existence of an output.

Proposition 22.383 (Knowledge-use evidence condition). A *knowledge-system return claim* should distinguish availability of an epistemic output from evidence that the output or associated infrastructure materially strengthens later inquiry, learning, interpretation, verification, or application.

Maintenance is especially consequential in knowledge systems because depreciation can remain invisible until retrieval, interpretation, or replication fails. Return can therefore take the form of maintaining epistemic conditions whose value becomes visible only under later use.

Definition 22.384 (Epistemic maintenance liability). An *epistemic maintenance liability* is a future resource, labor, governance, documentation, preservation, or updating requirement necessary to keep a knowledge asset or knowledge-generating relation usable for the function attributed to it.

Proposition 22.385 (Epistemic-return maintenance condition). *Where later knowledge use depends materially on preservation or updating, evaluation of knowledge-system return should include the associated maintenance liabilities and the arrangements through which they are expected to be met.*

Knowledge-system return also raises questions of contribution and capture. Research can build on prior public knowledge, community expertise, data contributors, technical maintainers, or local interpretive systems while later control becomes concentrated elsewhere. The existence of downstream innovation therefore does not establish adequate return to the epistemic relations on which that innovation depended.

Definition 22.386 (Epistemic return gap). An *epistemic return gap* is a material divergence between the epistemic capacities or infrastructures relied upon by a value-generating process and the later conditions returned to sustain, recognize, or develop those capacities or infrastructures.

22.8.4 Capability Return

Capability-return research asks whether value generated through economic activity re-enters individuals or collectives in ways that expand, preserve, restore, or diversify their effective ability to act. A resource transfer can support capability return,

but the two are analytically distinct because effective capability depends on conversion conditions, institutions, relations, time, health, knowledge, authority, and other enabling conditions. The research task is therefore to trace whether returned conditions become practically usable capacities.

Definition 22.387 (Capability return). A *capability return* is a generative return that materially changes an individual or collective position's effective ability to undertake, sustain, revise, or initiate valued activities relevant to the research question.

Definition 22.388 (Capability-return pathway). A *capability-return pathway* is the sequence of resource, relational, institutional, epistemic, embodied, technical, or organizational conditions through which a returned value-bearing condition becomes an effective later capability.

Capability return can occur through learning, health, time autonomy, infrastructure, access rights, organizational authority, legal standing, collective coordination, financial slack, or improved conversion conditions. Different pathways can lead to similar observed activity while carrying different durability or dependence. Research should therefore avoid treating the final action alone as sufficient evidence of the capability architecture that enabled it.

Proposition 22.389 (Capability-realization condition). A *capability-return claim* should identify evidence that the returned condition changed effective practical ability, while preserving the conversion conditions and dependencies through which that ability became usable.

A further distinction concerns capability preservation. Return can maintain existing ability under adverse conditions even when no expansion is observed. Preventive health, maintenance of public infrastructure, childcare support, institutional continuity, or debt relief can prevent erosion. Counterfactual reconstruction may therefore be necessary to identify return whose principal effect is preservation.

Definition 22.390 (Capability preservation return). A *capability preservation return* is a generative return whose primary evidenced effect is to prevent or reduce deterioration of an effective capability relative to a defensible counterfactual or historical baseline.

Proposition 22.391 (Capability-return counterfactual condition). *Where the principal claimed return is prevention of capability loss, evaluation should state the counterfactual or historical baseline against which preservation is inferred and the uncertainty attached to that inference.*

Collective capability also deserves separate analysis. A team, community, cooperative, research group, institution, or public system may develop capacities that cannot be assigned additively to individual members. Return can therefore renew shared procedures, coordination, legitimacy, infrastructure, or collective authority even where individual resource positions remain unchanged.

Definition 22.392 (Collective capability return). A *collective capability return* is a generative return that materially strengthens a capability requiring coordinated relations, shared infrastructure, institutional authority, or another higher-order condition that cannot be represented adequately as the sum of individual capacities.

22.8.5 Future-Option Return

Future-option return concerns the renewal or expansion of practical possibility structures. A return can be economically significant because it preserves exit, revisability, interoperability, diversity, slack, experimentation, institutional alternatives, ecological resilience, or another condition that keeps future action paths reachable. These possibilities may remain unused during the observation period, making their empirical study more difficult than the study of realized outcomes.

Definition 22.393 (Future-option return). A *future-option return* is a generative return that materially preserves, restores, expands, diversifies, or improves access to future practical possibilities relevant to a specified position, relation, or system.

Definition 22.394 (Option-supporting condition). An *option-supporting condition* is a resource, right, capability, relation, infrastructure, ecological state, information condition, institutional rule, or organizational property that materially contributes to keeping a specified future possibility practically reachable.

Research on option return should distinguish an observed option from a capacity to generate new options. A modular technical system may preserve multiple known pathways; a research capability can also create possibilities that were not previously specified. GRE therefore needs a stronger object than static menu expansion.

Definition 22.395 (Option-generative return). An *option-generative return* is a future-option return that strengthens the capacity of a position or configuration to create, discover, recognize, or institutionalize additional practical possibilities as conditions evolve.

Proposition 22.396 (Option-generation distinction). *Evidence that a return preserves a larger set of currently identifiable options should be distinguished from evidence that it improves the capacity to generate or recognize options that are presently unspecified.*

Option return is also distributional. A reform can expand one position's flexibility while narrowing another's exit or increasing dependency. Research should therefore identify whose future options are preserved or generated and which alternatives are intentionally or incidentally closed.

Definition 22.397 (Option-incidence profile). An *option-incidence profile* records the positions whose future possibilities are created, preserved, transformed, or foreclosed by a return process, together with the relevant time horizon, enabling conditions, dependencies, and uncertainty.

Proposition 22.398 (Option-return incidence condition). *A claim of future-option return should preserve materially divergent option effects across positions and times rather than treating expansion of one actor's or institution's option space as system-wide generative improvement.*

22.8.6 Equivalence and Non-Equivalence

Generative return frequently crosses value forms. Financial revenue can renew care capacity, knowledge can support institutional legitimacy, ecological restoration can improve material security, and recognition can expand access to participation. Research therefore needs a disciplined account of when returned conditions can substitute for depleted generative inputs and when they remain non-equivalent.

Definition 22.399 (Return-equivalence claim). A *return-equivalence claim* states that

a returned condition and a depleted, contributed, or required generative condition are substitutable with respect to a specified function, target, scale, horizon, and evidential domain.

Definition 22.400 (Return-equivalence signature). A *return-equivalence signature* records the function, target, properties, affected positions, scale, temporal horizon, and uncertainty with respect to which a return-equivalence claim is made.

The requirement of a signature prevents a local substitution from becoming a universal value equation. Financial compensation can be equivalent to a maintenance requirement with respect to purchasing replacement equipment while remaining non-equivalent to lost trust, ecological damage, tacit knowledge, legal autonomy, or irreversible time. Likewise, training can replace some lost expertise while failing to restore historical relationships through which that expertise operated.

Proposition 22.401 (Scoped return equivalence). A *return-equivalence claim warrants substitution only with respect to the properties and domain declared in its equivalence signature; it does not establish identity or unrestricted commensurability between the returned and source conditions.*

Definition 22.402 (Generative replenishment equivalence). *Generative replenishment equivalence* holds, within a stated signature, when a returned condition restores the relevant generative function of a depleted or expended condition to a defensibly comparable level over the specified horizon.

Replenishment can also fail because the source condition has historical specificity. Replacing a long-standing local institution with a new service provider may preserve output while losing legitimacy, memory, or coordination capacity. Replacing ecological habitat with financial assets can support some human capabilities while leaving ecological functions unrestored. Non-equivalence should therefore be recorded positively as a substantive result rather than treated as measurement failure.

Definition 22.403 (Return non-equivalence record). A *return non-equivalence record* identifies the source and returned conditions, the attempted comparison or substitution, the dimensions that remain materially non-equivalent, the evidence for that judgment, and the consequences for generative capacity or evaluation.

Proposition 22.404 (Non-equivalence preservation condition). *Where a returned condition restores some generative functions while leaving other materially relevant functions, histories, rights, relations, or ecological conditions unrestored, research should preserve the partial nature of replenishment rather than aggregate the result into complete return adequacy.*

22.8.7 Delayed Return

Delayed-return research studies generative effects whose re-entry becomes materially effective only after substantial temporal separation from the originating process. Delay can arise from learning, biological regeneration, institutional maturation, infrastructure completion, network formation, cumulative legitimacy, demographic change, scientific diffusion, or sequences of complementary investment. The principal challenge is to preserve provenance as intervening history accumulates.

Definition 22.405 (Generative-return latency). *Generative-return latency* is the interval between an originating generative process and the point at which a returned condition begins to make a materially evidenced contribution to renewal or expansion

of the specified generative target.

Definition 22.406 (Return maturation process). *A return maturation process is the sequence of persistence, learning, maintenance, accumulation, conversion, institutionalization, ecological regeneration, coordination, or other mechanisms through which a potential return becomes generatively effective over time.*

Delay increases attribution difficulty because later conditions can depend on many intervening events. Research should therefore distinguish an originating contribution from subsequent complementary causes. A scholarship can contribute to later professional capability while institutions, family support, labor-market conditions, and later learning remain causally relevant. An ecological intervention can contribute to restoration while weather, regulation, neighboring land use, and species dynamics affect the result. Distributed causal contribution is compatible with generative return; exclusive attribution is unnecessary.

Definition 22.407 (Delayed-return provenance). *Delayed-return provenance records the originating process, intermediate mechanisms, complementary conditions, interruptions, competing explanations, later regenerative target, and evidential links required to reconstruct a delayed generative return.*

Proposition 22.408 (Delayed attribution condition). *The evidential burden for a delayed generative-return claim increases with material temporal separation, causal branching, changing institutions, and intervening conditions, and the claim should preserve distributed contribution where exclusive attribution is unsupported.*

Maintenance can mediate delayed return. A research archive may produce future epistemic value only if maintained; ecological restoration can mature only if later disturbance remains within tolerable bounds; infrastructure can support later opportunity only if upkeep preserves usability. The return process can therefore depend on continuing inputs whose omission would break the pathway.

Definition 22.409 (Return-maintenance dependency). *A return-maintenance dependency is a condition in which realization or persistence of a generative return depends materially on maintenance, protection, updating, care, or complementary support occurring after the originating process.*

Proposition 22.410 (Maintenance-mediated return condition). *Where delayed return depends materially on subsequent maintenance or complementary support, evaluation should treat those contributions as part of the return pathway rather than assigning the later effect solely to the originating episode.*

Temporal evaluation should also distinguish delay from duration. A return can emerge slowly and then persist, emerge quickly and decay, recur episodically, or mature in several stages. A single end-point measurement can therefore misrepresent the return process.

Definition 22.411 (Generative-return temporal profile). *A generative-return temporal profile records latency, maturation, realization, persistence, decay, recurrence, maintenance dependencies, and the horizon over which a return claim is evaluated.*

22.8.8 Justice of Return

Justice-of-return research evaluates how generative returns should be distributed, governed, recognized, and sustained when economic value depends on multiple contributors, maintainers, communities, infrastructures, ecological conditions, and fu-

ture positions. Descriptive evidence of contribution or regeneration does not determine a unique normative rule. Entitlement, reciprocity, desert, equality, capability, recognition, repair, autonomy, sustainability, property, democratic participation, and other normative traditions can support different judgments. The research programme therefore keeps the empirical architecture of return distinct from the normative principles used to evaluate it.

Definition 22.412 (Justice-of-return profile). A *justice-of-return profile* records the generators, maintainers, owners, contributors, affected positions, communities, institutions, ecological conditions, and future positions relevant to a return process; the benefits and burdens involved; governance and contestability; dependencies and alternatives; historical claims; and the normative principles applied in evaluation.

Contribution is one justice-relevant object, but many generative conditions are inherited, publicly financed, ecologically supplied, collectively maintained, or historically accumulated. Visible final actors therefore need not account for the full value-generating process, while diffuse contributors can remain difficult to identify.

Definition 22.413 (Generative contribution claim). A *generative contribution claim* is a scoped empirical claim that a position, relation, institution, community, infrastructure, ecological condition, or historical process made a materially identifiable contribution to the value-generating process relevant to a return analysis.

Proposition 22.414 (Contribution-entitlement separation). *Evidence of generative contribution is relevant to some theories of return justice but does not by itself establish the magnitude, form, recipient, governance rule, or exclusivity of a justified return.*

Maintenance and exposure also matter. Positions that sustain an infrastructure, absorb environmental burden, provide care, preserve knowledge, bear risk, or keep a collective relation functioning may have justice-relevant claims even where their contribution is absent from conventional output accounting. Research should therefore document maintenance and burden as well as visible production.

Definition 22.415 (Return-burden relation). A *return-burden relation* records how the benefits of generative return and the burdens of generation, maintenance, risk, depletion, waiting, or repair are distributed across materially affected positions and times.

Proposition 22.416 (Burden-return visibility condition). *Where materially relevant burdens are displaced to positions different from those receiving return, justice analysis should preserve that incidence rather than evaluate return solely through the distribution of visible benefits.*

Governance is another independent dimension. A return can be substantively valuable while governed through exclusionary procedures, or formally participatory while producing little regenerative effect. Research should therefore distinguish destination, substantive renewal, and authority over return.

Definition 22.417 (Return-governance right). A *return-governance right* is an effective right or capacity to participate in, receive information about, contest, authorize, revise, or otherwise influence decisions concerning the form, destination, timing, or use of generative return.

Proposition 22.418 (Return-governance distinction). *The justice of a return arrangement should distinguish the distribution of returned value from the distribution of authority over how return is defined, allocated, monitored, and revised whenever governance materially affects affected positions.*

Intergenerational and ecological return further complicate the analysis because future persons and nonhuman systems may be unable to participate directly in present governance. A return can increase current consumption while degrading ecological capacity or foreclosing later options; it can also impose present maintenance burdens to preserve later capability. The appropriate normative treatment depends on the theory applied, but the empirical record should preserve these temporal and ecological consequences.

Definition 22.419 (Intergenerational return record). An *intergenerational return record* identifies the present and future positions materially affected by a generative-return process, the capacities and burdens transmitted across time, relevant irreversibilities or option effects, maintenance requirements, and uncertainty needed for normative evaluation.

The section closes with a research boundary. Generative-return analysis can identify source relations, regenerative targets, re-entry pathways, renewal, delay, equivalence, non-equivalence, incidence, and governance. It does not convert those descriptions into a universal rule that value should return to its source in the same form or proportion. Some valuable processes depend on asymmetric contribution, public provision, cross-subsidy, redistribution, or return to positions different from those that produced an immediate output. The research task is to reconstruct the architecture sufficiently well that normative arguments can state what kind of return they justify and why.

Proposition 22.420 (Generative-return research boundary). A *GRE generative-return study* is analytically adequate when it identifies the originating generative process, regenerative targets, return pathways, affected positions, temporal and maintenance structure, relevant equivalence or non-equivalence, and remaining uncertainty while keeping descriptive regeneration claims distinct from normative judgments about justified return.

The next section places these temporally extended return processes within the broader research architecture of generative spacetime.

22.9 Research on Generative Spacetime

The role of this section is to convert GRE's account of generative spacetime into an explicit research programme. Earlier chapters established that economic processes can depend on event order, trajectory history, delay, unequal temporal position, scale, reachability, and historically transformed possibility. The present task is methodological: to specify how those claims can be investigated without treating time as a uniform background variable or spacetime language as an ontological conclusion. The objective is to define research objects, evidential burdens, comparison rules, and failure conditions for event-sensitive and history-bearing economic inquiry. The discussion proceeds through economic events, trajectories, temporal depth, delayed generation, multiple timescales, heterogeneous presents, cross-scale coupling, historical contingency, and comparative research on structural preservation across representation families. The method is plural and resolution-sensitive. Longitudinal data, sequence analysis, event-history reconstruction, process tracing, archival research, ethnography, institutional analysis, temporal networks, comparative historical inquiry, simulation, and formal dynamical models can each be appropriate when their temporal

and scalar assumptions match the mechanism under study.

Generative-spacetime research begins with a proportionality principle. A static representation remains adequate where order, duration, latency, temporal position, historical inheritance, and cross-scale propagation do not materially alter the claim. A richer spatiotemporal representation becomes necessary when one or more of those dimensions changes what can be explained, compared, attributed, or evaluated. Research should therefore earn additional temporal complexity through the object of inquiry rather than assume it by default.

Definition 22.421 (Generative-spacetime research object). A *generative-spacetime research object* is a provisionally bounded economic configuration studied through the events, trajectories, temporal relations, spatial or relational positions, scale relations, and historically conditioned possibilities required to explain a specified generative process.

Definition 22.422 (Spatiotemporal resolution declaration). A *spatiotemporal resolution declaration* states the temporal unit, spatial or relational scale, event granularity, observation interval, historical horizon, and cross-scale boundaries at which a generative-spacetime claim is intended to hold.

Proposition 22.423 (Resolution adequacy condition). A *generative-spacetime representation* is adequate only where its temporal and scalar resolution preserves the events, orderings, delays, couplings, and affected positions material to the research claim.

Table 22.9 summarizes the principal research domains developed in this section.

22.9.1 Economic Events

Economic-event research studies occurrences whose timing or bounded transition materially changes an economic configuration. The event can be contractual, organizational, institutional, technological, relational, epistemic, ecological, financial, or political insofar as it changes an economically relevant state, relation, capacity, constraint, right, expectation, or option structure. The principal research problem is event construction: empirical records rarely arrive with analytically correct boundaries already attached.

Definition 22.424 (Economic-event specification). An *economic-event specification* records the occurrence or transition being treated as an event, its provisional start and end boundaries, participants, affected positions, location or relational field, relevant preconditions, immediate consequences, evidential sources, and the scale at which the event is analytically meaningful.

Event boundaries should follow the mechanism. A law can be enacted on one date, implemented later, interpreted through subsequent decisions, and become effectively accessible at still another time. A platform interface can change instantaneously while behavioral adaptation unfolds over months. A merger can have a legal closing date while integration and restructuring remain processual. Research can therefore distinguish several event boundaries within one wider transformation.

Definition 22.425 (Event-boundary profile). An *event-boundary profile* records alternative defensible boundaries for an event and the consequences of each boundary choice for timing, attribution, comparison, and measured effect.

Proposition 22.426 (Event-boundary sensitivity condition). Where reasonable alternative event boundaries materially change estimated sequence, incidence, attribution,

Table 22.9: Principal research domains in generative spacetime

Research domain	Primary object	Principal evidential burden
Economic events	Bounded economically relevant occurrences and transitions	Justify event boundaries, timing, participants, affected positions, and relation to surrounding processes
Trajectories	History-bearing sequences or partially ordered configurations	Preserve state meaning, coupling, divergence, branching, and comparability across observations
Temporal depth	Historical horizon required for explanation	Show which inherited conditions remain causally or generatively relevant and where truncation changes inference
Delayed generation	Temporally separated formation and realization of effects	Distinguish accumulation, activation, realization, observation, maintenance, and competing explanations
Multiple timescales	Processes operating at differentiated characteristic durations	Identify relevant timescales, interactions, horizon mismatch, and limits of scale separation
Heterogeneous presents	Unequal temporal positions within a shared nominal present	Reconstruct temporal position, waiting capacity, institutional cadence, and consequences of misalignment
Cross-scale coupling	Transmission among individual, organizational, institutional, territorial, or other scales	Identify coupling pathways, aggregation or disaggregation loss, feedback, and scale-specific incidence
Historical contingency	Sequence-sensitive branching of later possibility	Establish plausible branch points, enabling conditions, reinforcement, and limits of historical portability
Representation families	Alternative carriers for the same spatiotemporal object	Compare informational recoverability, native incidence and attachment, generative reconstruction, historical preservation, identifiability, and assumption burden

or effect, the event definition should be treated as part of the research uncertainty rather than as fixed preprocessing.

Events can also occur in bundles. A regulatory announcement, financing decision, organizational restructuring, and public controversy can become mutually conditioning within a short interval. Treating one event as isolated can misattribute a change produced by their conjunction.

Definition 22.427 (Event bundle). An *event bundle* is a set of temporally proximate or causally connected events whose joint configuration is materially relevant to an observed transition and whose contributions cannot be adequately represented as independent additive occurrences at the chosen resolution.

Definition 22.428 (Event-process registry). An *event-process registry* is a research record linking bounded events to the longer processes in which they participate, including antecedent formation, implementation, adaptation, maintenance, feedback, and later reinterpretation.

Proposition 22.429 (Event-process linkage condition). An *event-based explanation* is strengthened when it states which surrounding processes make the event possible,

transmit its effects, or change its meaning over time.

22.9.2 Trajectories

Trajectory research follows economically relevant configurations through ordered or partially ordered change. The trajectory object can be a resource position, value form, relation, capability, institution, organization, infrastructure, ecological condition, or a coupled configuration containing several such dimensions. The objective is to preserve historical dependence without assuming that all dimensions evolve along one common line.

Definition 22.430 (Trajectory reconstruction). A *trajectory reconstruction* is an evidence-linked account of changes in a specified economic object or configuration across ordered events or states, together with the rules used to establish continuity, transformation, branching, and uncertainty.

Continuity is an empirical claim. An organization that retains its legal name can undergo sufficient changes in ownership, personnel, purpose, technology, or governance that treating it as one unchanged trajectory becomes misleading. Conversely, a capability or relation can persist through changes in its material carrier. Research therefore needs explicit continuity criteria.

Definition 22.431 (Trajectory continuity criterion). A *trajectory continuity criterion* states the properties whose persistence or traceable transformation warrants treating observations at different times as belonging to one analytically continuous trajectory.

Proposition 22.432 (Trajectory identity condition). *Claims about change along one trajectory should identify the continuity criterion that connects temporally separated observations; nominal labels or record identifiers alone are insufficient where the underlying economic object has materially transformed.*

Many economic histories require coupled trajectories. Household income, institutional eligibility, debt, care burden, health, and labor-market participation can interact while moving at different rates. Research can preserve those histories separately and then study their coupling rather than collapse them into one composite trajectory prematurely.

Definition 22.433 (Coupled trajectory family). A *coupled trajectory family* is a set of distinct but materially interacting trajectories whose joint evolution is required to explain the research object while preserving the identity and evidential provenance of each constituent trajectory.

Definition 22.434 (Trajectory divergence). *Trajectory divergence* is the historically situated separation of trajectories that shared a relevant prior configuration, comparison class, or enabling condition and later develop materially different states, relations, capacities, or option structures.

Proposition 22.435 (Divergence explanation condition). *A trajectory-divergence claim should distinguish differences attributable to prior conditions, intervening events, differential exposure, endogenous feedback, and measurement or classification changes at the resolution appropriate to the inquiry.*

Branching also matters when several later paths remain possible. Retrospective reconstruction can make one realized sequence appear inevitable because unrealized alternatives disappear from ordinary records. Historical research should recover plausible alternatives where they materially affect interpretation of choice, con-

straint, and contingency.

Definition 22.436 (Trajectory branch record). A *trajectory branch record* identifies a historically situated point at which multiple later pathways were practically reachable, the conditions supporting each pathway, the events or decisions associated with realized selection, and the evidential standing of unrealized alternatives.

22.9.3 Temporal Depth

Temporal-depth research asks how far into prior history an explanation must reach before the inherited conditions relevant to the present claim are adequately represented. Temporal depth is therefore mechanism-relative. A price response can require minutes of high-frequency history; institutional legitimacy can require decades; ecological regeneration, infrastructure, educational capability, or intergenerational wealth can require still longer horizons.

Definition 22.437 (Explanatory temporal depth). *Explanatory temporal depth* is the historical horizon required to reconstruct the inherited events, relations, capacities, institutions, constraints, and prior transformations that materially condition the research claim at its declared resolution.

A long observation window does not guarantee adequate temporal depth. A data set can extend over thirty years while beginning after the institution, boundary, technological standard, or ownership structure that generated the process being studied. Conversely, a shorter window can be adequate where earlier history no longer changes the mechanism or comparison.

Definition 22.438 (Temporal truncation risk). *Temporal truncation risk* is the risk that the chosen historical starting point omits inherited conditions whose exclusion materially changes attribution, baseline construction, comparison, or interpretation of later dynamics.

Proposition 22.439 (Temporal-depth adequacy condition). A *historical horizon* is adequate when extending the reconstruction further into the past is unlikely, given available evidence and the stated mechanism, to change the material interpretation of the claim; this adequacy should remain revisable as new evidence appears.

Baselines inherit this problem. A present condition described as decline, recovery, normality, or exceptional growth depends on the historical period selected for comparison. Research should therefore identify whether the baseline is pre-intervention, pre-crisis, pre-institutional change, long-run average, counterfactual estimate, or another justified reference state.

Definition 22.440 (History-sensitive baseline). A *history-sensitive baseline* is a comparison state whose temporal location and substantive meaning are justified in relation to the process history rather than selected solely for data convenience.

Definition 22.441 (Historical inheritance map). A *historical inheritance map* records the material, relational, institutional, epistemic, ecological, and symbolic conditions inherited from earlier periods that remain relevant to the present research object, together with their persistence or transformation pathways.

Proposition 22.442 (Historical inheritance condition). Where present outcomes depend materially on inherited conditions, those conditions should enter the explanatory architecture either directly or through a justified summary representation whose information loss is stated.

22.9.4 Delayed Generation

Delayed-generation research studies processes in which a generative condition is formed at one time while its economically relevant realization occurs later. The research challenge is to separate distinct temporal stages that ordinary before-and-after comparison can conflate: formation, accumulation, maintenance, activation, realization, and observation. The delay itself can be economically consequential because actors differ in their capacity to wait, maintain an unrealized condition, or survive until realization.

Definition 22.443 (Delayed-generation episode). A *delayed-generation episode* is a historically reconstructable process in which an earlier event or condition contributes to a later economically relevant effect through a specified period of latency, accumulation, maintenance, mediation, or threshold-dependent activation.

Definition 22.444 (Delay-stage profile). A *delay-stage profile* records, where empirically distinguishable, the timing of generative-condition formation, accumulation, maintenance, activation, realization, observation, and subsequent stabilization or decay.

This staging helps distinguish delayed generation from delayed observation. A capability may already be operative before an administrative indicator registers it; ecological damage can already affect production before formal reporting; an institutional rule can alter expectations before implementation. Measurement timing should therefore be treated separately from effect timing.

Definition 22.445 (Observation-realization gap). An *observation-realization gap* is the temporal separation between the point at which an economically relevant effect becomes materially operative and the point at which available measurement, records, classification, or interpretation makes that effect observable to the research process.

Proposition 22.446 (Delayed-generation evidence condition). A *delayed-generation claim* should identify a plausible mechanism connecting earlier formation to later realization, distinguish realization from observation where material, and record maintenance conditions, intervening causes, competing explanations, and uncertainty across the delay interval.

Long delays increase the space for additional causes. Attribution should therefore preserve distributed contribution. An educational investment can contribute to later capability while family support, institutional quality, labor demand, health, and subsequent learning also matter. The generative claim concerns contribution through a traced pathway, not exclusive causal ownership.

Definition 22.447 (Delayed-attribution record). A *delayed-attribution record* identifies the originating condition, intermediate mechanisms, maintenance inputs, complementary causes, interruptions, branch points, realization event, observation event, and uncertainty required to assess a temporally extended generative claim.

Proposition 22.448 (Delay-attribution proportionality). *The evidential burden for attribution should increase with temporal separation, causal branching, changing institutions, unobserved maintenance, and multiplicity of plausible intervening causes.*

22.9.5 Multiple Timescales

Multiple-timescale research studies economic processes whose constituent dynamics operate at materially different characteristic durations. Market prices, organiza-

tional routines, infrastructure, legal regimes, demographic change, ecological regeneration, scientific capability, and social norms can evolve at different rates while remaining mutually conditioning. The objective is to identify timescales empirically before imposing a fast–slow decomposition. Section 22.9.5 therefore prepares the more specialized programme developed in Section 508 without presuming that every multiscale process has clean scale separation.

Definition 22.449 (Timescale profile). A *timescale profile* records the characteristic durations, update frequencies, persistence intervals, latency structures, and observation resolutions of the processes materially relevant to a research object.

Definition 22.450 (Timescale interaction map). A *timescale interaction map* records the pathways through which processes operating at different characteristic durations condition, constrain, amplify, dampen, synchronize, or transform one another.

Temporal aggregation can hide these interactions. Annual observations can erase short-lived shocks whose cumulative effects alter slower institutional trajectories. High-frequency records can make slower background change appear constant even when gradual transformation is central to the long-run process. Research should therefore align observation intervals with the dynamics being claimed.

Definition 22.451 (Timescale aliasing). *Timescale aliasing* occurs when the temporal resolution of observation or aggregation causes a process operating at one timescale to be misidentified, obscured, or attributed to dynamics at another timescale.

Proposition 22.452 (Temporal-resolution matching condition). A *multiple-timescale study* should use observation and aggregation intervals capable of resolving the processes material to its mechanism claims or explicitly state the resulting aliasing and identification limits.

Evaluation horizons create another problem. A policy can improve a fast outcome while degrading slower capacity, or impose immediate costs while producing later benefits. The relevant result depends partly on the time horizon, but horizon selection should follow the substantive claim rather than the desired sign of the result.

Definition 22.453 (Evaluation-horizon profile). An *evaluation-horizon profile* records the outcomes, affected positions, maintenance burdens, option effects, and uncertainties observed across materially distinct short, medium, and long horizons relevant to an intervention or process.

Proposition 22.454 (Horizon plurality condition). *Where the sign, incidence, or mechanism of an effect changes materially across time horizons, research should preserve that horizon dependence rather than report one temporally aggregated judgment as the process-wide result.*

22.9.6 Heterogeneous Presents

Research on heterogeneous presents asks how positions that coexist at one calendar date can nevertheless occupy different effective temporal conditions. Institutions can process change at different cadences; technologies diffuse unevenly; legal rights become practically usable at different times; generations inherit different infrastructures and obligations; organizations differ in planning horizons; and households differ in their capacity to wait through delayed processes. The common date therefore does not guarantee a common practical present.

Definition 22.455 (Temporal-position profile). A *temporal-position profile* records the

effective temporal conditions of a position, including access timing, waiting periods, deadlines, institutional cadence, technological availability, planning horizon, accumulated history, expected duration, and capacity to absorb delay.

Definition 22.456 (Waiting capacity). *Waiting capacity* is the effective ability of a position to sustain itself, preserve relevant options, and remain eligible or capable during a delay before an expected resource, right, return, decision, or opportunity becomes usable.

Waiting capacity can turn nominally equal timing into unequal access. Two applicants can face the same six-month process while only one can finance housing, care, legal representation, or foregone income through the delay. Temporal inequality can therefore arise from the interaction between common institutional timing and heterogeneous capacities.

Definition 22.457 (Temporal misalignment). *Temporal misalignment* is a materially consequential mismatch among the timing, cadence, horizon, or duration requirements of interacting positions, institutions, technologies, or processes.

Proposition 22.458 (Heterogeneous-present evidence condition). *A heterogeneous-present claim should identify the temporal dimensions on which positions differ and demonstrate how those differences materially affect access, burden, coordination, expectation, capability, or later trajectory.*

Temporal position can also be relational. One organization's accelerated decision cycle can impose volatility or compressed deadlines on suppliers, workers, regulators, or communities. Research should therefore examine how temporal advantages are produced through relationships rather than treating pace as a property of isolated actors.

Definition 22.459 (Relational temporal advantage). *A relational temporal advantage* is an effective advantage arising because a position can act, wait, delay, accelerate, revise, or commit on temporal terms that interacting positions cannot match without materially greater burden or loss of options.

Proposition 22.460 (Temporal-incidence condition). *Where one position's timing choices materially alter the deadlines, waiting burdens, adjustment periods, or option preservation of others, temporal incidence should be included in analysis of the shared process.*

22.9.7 Cross-Scale Coupling

Cross-scale research studies how processes at one analytical scale condition dynamics at another. Individual choices can aggregate into organizational routines; organizational practices can alter institutional implementation; institutional rules can reshape household trajectories; local ecological change can propagate through regional infrastructure; platform-level design can affect millions of individualized interactions. Scale is therefore part of the mechanism rather than a neutral reporting level.

Definition 22.461 (Scale-specific state). *A scale-specific state* is a representation of an economic configuration whose variables, relations, boundaries, and observables are defined for a stated analytical scale and whose meaning need not be preserved automatically under aggregation or disaggregation.

Definition 22.462 (Cross-scale coupling pathway). *A cross-scale coupling pathway* is a mechanism through which changes represented at one scale materially alter states,

relations, constraints, or transition possibilities represented at another scale.

Aggregation can create new regularities while obscuring the distribution of contributing processes. Disaggregation can reveal heterogeneous incidence while losing collective properties that exist only at higher order. Research should therefore treat upward and downward translation as potentially lossy operations.

Definition 22.463 (Scale-translation remainder). A *scale-translation remainder* is the information, relation, collective property, heterogeneity, or mechanism materially lost when a research object is translated from one analytical scale to another.

Proposition 22.464 (Scale-translation condition). A *cross-scale explanation* should identify which properties are preserved under aggregation or disaggregation and which materially relevant properties remain in the scale-translation remainder.

Feedback can create recursive coupling. An aggregate classification can change organizational incentives; organizations then alter individual behavior; changed behavior modifies the aggregate classification. Such processes require repeated movement across scales rather than a one-directional micro-to-macro or macro-to-micro account.

Definition 22.465 (Recursive scale coupling). *Recursive scale coupling* is a process in which changes propagated across scales subsequently modify the lower- or higher-scale conditions that generated the earlier propagation, producing historically dependent feedback across analytical levels.

Proposition 22.466 (Cross-scale attribution condition). *Where an observed outcome depends on recursive coupling across scales, causal attribution should preserve the interacting pathway rather than assign the result exclusively to one scale because its variables are easier to measure.*

22.9.8 Historical Contingency

Historical-contingency research asks how later economic possibilities depend on sequences that could plausibly have unfolded differently under the conditions of the time. Contingency is therefore distinct from pure randomness and from retrospective uncertainty. A contingent process can have structured mechanisms, constraints, and probabilities while remaining sensitive to sequence, timing, local events, or branching decisions whose alternatives were historically reachable.

Definition 22.467 (Historical contingency claim). A *historical contingency claim* states that a later economic configuration depends materially on one or more historically situated events, sequences, or branch selections for which substantively different later pathways were plausibly reachable from the prior configuration.

Definition 22.468 (Contingency window). A *contingency window* is a historically bounded interval during which alternative pathways remain practically reachable before reinforcement, institutionalization, investment, learning, ecological change, or another mechanism materially narrows later alternatives.

Research on contingency should avoid reconstructing unrealized alternatives from present preferences alone. Alternatives require historical evidence: proposals, plans, competing standards, rejected policies, organizational debates, technical options, legal possibilities, comparable cases, or other evidence that the pathway was genuinely available to relevant positions at the time.

Definition 22.469 (Historically reachable alternative). A *historically reachable alter-*

native is an unrealized pathway supported by contemporaneous evidence that relevant actors or configurations possessed sufficient enabling conditions for the alternative to be practically possible within the stated contingency window.

Proposition 22.470 (Contingency evidence condition). *A historical-contingency claim should identify the branch point, contemporaneously reachable alternatives, enabling and constraining conditions, mechanism of pathway selection, and subsequent reinforcement or transformation at the level supported by available evidence.*

Contingency also limits transfer. A mechanism observed in one historical sequence can travel poorly when the receiving configuration lacks the institutions, expectations, infrastructures, memories, or prior investments that made the mechanism effective in the original setting.

Definition 22.471 (Historical portability profile). *A historical portability profile records the inherited conditions, sequence dependencies, institutional complements, temporal expectations, and prior investments required for a finding or mechanism to remain applicable across historical contexts.*

Proposition 22.472 (Historical portability condition). *Transfer of a generative-spacetime finding across periods or settings should be conditioned on the historical structures required by the mechanism rather than inferred from surface similarity alone.*

Historical contingency does not imply analytical resignation. It changes the object of explanation. Research can ask which conditions widened or narrowed the contingency window, which events redirected trajectories, which relations transmitted reinforcement, and which interventions reopened alternatives after apparent closure.

Definition 22.473 (Contingency research portfolio). *A contingency research portfolio is a coordinated set of historical, comparative, empirical, and formal inquiries designed to test branch points, sequence sensitivity, reinforcement, path reopening, and the historical portability of generative mechanisms.*

Proposition 22.474 (Generative-spacetime research boundary). *A GRE generative-spacetime study is analytically adequate when it preserves the event boundaries, trajectory histories, temporal depth, delays, timescales, temporal positions, scale couplings, and historically contingent alternatives material to its claim while avoiding additional spatiotemporal complexity that does not change explanation or evaluation.*

The next research problem narrows one part of this programme. Multiple-timescale analysis establishes that economic processes can evolve at differentiated rates and can interact across those rates. Stronger fast–slow claims require additional evidence concerning characteristic variables, scale separation, cross-frequency interaction, synchronization, and breakdown of separation. The following section therefore develops a dedicated research programme for fast–slow economic dynamics.

22.9.9 Representation Families and Structural Preservation

Generative-spacetime research should also compare alternative representations of the same empirical object when the target inference depends on how higher-order structure is preserved. The research problem is not exhausted by asking which representation can encode the observed information. An enriched lower-dimensional carrier can be informationally sufficient while relocating higher-order incidence, attach-

ment, compositional closure, or refinement into labels and auxiliary data. A higher-dimensional cellular representation can make those relations native to the topology of the carrier, while introducing additional reconstruction and identifiability burdens.

Definition 22.475 (Representation-family benchmark). A *representation-family benchmark* compares two or more candidate representations of a common research object with respect to informational recoverability, native structural relations, generative reconstruction, historical preservation, empirical identifiability, interpretability, computational burden, and the conclusions that remain invariant or representation-dependent.

One useful benchmark compares an enriched event-coupling-primitive 2-complex with a CW-complex whose 2-skeleton preserves that architecture while higher cells retain higher-order attachment explicitly. The purpose is not to reward the representation with more dimensions. The benchmark asks whether the additional cellular structure changes what can be stated, reconstructed, tested, or compared about the target process.

The benchmark should distinguish several notions of equivalence. Two representations can be informationally intertranslatable while differing in which relations are structurally native. They can preserve the same generated endpoint while differing in how readily a generative history can be reconstructed. They can also agree on current structure while differing in the admissible transformations represented by their accompanying rule systems. Results should therefore state which equivalence notion is being claimed rather than treating successful encoding as full structural or generative equivalence.

Proposition 22.476 (Structural-preservation benchmark condition). A *higher-dimensional cellular representation adds research value only where it preserves or exposes target-relevant incidence, attachment, compositional, refinement, or generative relations in a way that yields a substantively clearer inference, discriminating test, reconstruction, or comparison than an enriched lower-dimensional alternative*.

Negative results are informative here. If a carefully enriched 2-complex and an explicit higher CW-complex support the same empirically relevant conclusions at lower reconstruction cost, the benchmark supports retaining the simpler carrier for that inquiry. If conclusions concerning higher-order formation, obstruction, refinement, or historical genealogy depend on making attachment native to the carrier, the benchmark identifies a bounded domain in which the higher CW structure earns its additional complexity.

22.10 Research on Fast–Slow Economic Dynamics

The role of this section is to develop a research programme for economic processes in which materially different rates of change interact. Section 22.9 established a broader generative-spacetime architecture for events, trajectories, temporal depth, delay, multiple timescales, heterogeneous presents, cross-scale coupling, and historical contingency. The present section narrows that architecture to a stronger class of claims: some economic variables, relations, institutions, or capacities change sufficiently faster than others that their interaction can be represented through a fast–slow decomposition. The objective is to specify how such decompositions can be identified, tested, revised, and rejected. The discussion proceeds through fast variables,

slow variables, scale separation, breakdown of scale separation, cross-frequency coupling, synchronization, desynchronization, empirical signatures, and limits of the framework. The method is mechanism-relative and empirically plural. Time-series analysis, panel data, event histories, longitudinal institutional records, process tracing, frequency-domain methods, temporal networks, comparative historical inquiry, experiments, simulation, and formal dynamical models can each contribute when their sampling interval and temporal assumptions match the process under study.

Fast–slow research begins with a relational principle. A variable is not intrinsically fast or slow. Its classification depends on the characteristic change rate relevant to a stated mechanism, comparison set, scale, and observation horizon. Prices can move quickly relative to infrastructure while moving slowly relative to automated order placement. Organizational routines can be slow relative to daily production decisions and fast relative to demographic or ecological regeneration. Research should therefore state the temporal relation being asserted before attaching fast or slow labels.

Definition 22.477 (Fast–slow research object). A *fast–slow research object* is an economic configuration in which two or more empirically distinguishable processes operate at materially different characteristic rates and interact in a manner relevant to the research claim.

Definition 22.478 (Timescale-reference profile). A *timescale-reference profile* records the process, variable, unit of change, characteristic duration or rate, observation interval, comparison process, spatial or relational scale, and historical horizon used to classify a component as relatively fast or slow.

Proposition 22.479 (Relational timescale condition). A *fast or slow classification* is analytically adequate only when the reference process, characteristic rate, observation resolution, and mechanism for which the distinction matters are stated explicitly.

Table 22.10 summarizes the principal research domains developed in this section.

22.10.1 Fast Variables

Research on fast variables studies processes whose economically relevant state changes rapidly relative to another process in the same explanatory architecture. Examples can include transaction prices relative to productive capacity, short-term liquidity relative to legal institutions, inventory adjustments relative to infrastructure, platform ranking changes relative to organizational routines, or daily labor scheduling relative to skill formation. The research task is to identify a characteristic rate of change that is substantively connected to the mechanism rather than to label any high-frequency series as fast.

Definition 22.480 (Fast variable). A *fast variable* is a measured or reconstructed economic state component whose materially relevant adjustment, fluctuation, or transition occurs at a characteristic rate substantially shorter than the reference process used in the research claim.

Speed and volatility should remain distinct. A variable can update frequently while remaining close to a stable level, and a slowly evolving variable can undergo a large structural change over a longer interval. Frequency of observation can also create an illusion of speed: daily measurement of one process and annual measurement of another does not establish different underlying dynamics.

Definition 22.481 (Fast-process identification profile). A *fast-process identification*

Table 22.10: Principal research domains in fast–slow economic dynamics

Research domain	Primary object	Principal evidential burden
Fast variables	Rapidly changing process relative to a stated mechanism	Identify rate, observation resolution, persistence, and causal relevance rather than equating volatility with speed
Slow variables	Slowly changing conditions, stocks, relations, or institutions	Establish persistence, cumulative change, hidden adjustment, and the horizon on which slow movement becomes consequential
Scale separation	Relative independence created by sufficiently different characteristic rates	Demonstrate the empirical interval over which one process can be approximated as quasi-static or averaged
Breakdown of separation	Conditions under which the decomposition ceases to preserve the mechanism	Detect acceleration, deceleration, threshold crossing, feedback, or state change that collapses the prior timescale distinction
Cross-frequency coupling	Dependence among processes operating at different temporal frequencies	Identify direction, lag, modulation, mediation, and competing pathways without inferring mechanism from spectral association alone
Synchronization	Increasing temporal coordination among previously distinct processes	Distinguish phase alignment, common forcing, institutional coordination, and endogenous coupling
Desynchronization	Loss or absence of consequential temporal alignment	Identify mismatch, buffering, resilience, fragmentation, and distribution of timing burdens
Empirical signatures	Observable evidence supporting or challenging fast–slow claims	Match sampling frequency, indicators, intervention timing, structural breaks, and model diagnostics to the hypothesized process
Framework limits	Cases where fast–slow decomposition obscures the object	Record ambiguous rates, continuous spectra, endogenous timescales, historical shifts, and omitted relational or normative content

profile records the candidate variable, update mechanism, observed adjustment time, persistence, measurement interval, reference slow process, and evidence that rapid change is substantively relevant to the mechanism being studied.

Proposition 22.482 (Fast-process evidence condition). *A fast-process claim should identify rapid adjustment in the underlying process rather than infer speed solely from dense sampling, noisy measurement, or high variance.*

Fast processes can be adaptive. Firms can update prices, orders, inventories, or staffing in response to signals generated by slower institutions or infrastructures. Such adaptation can partly compensate for slow constraints while also transferring burden to positions with lower adjustment capacity. Research should therefore ask who can respond at the fast timescale and who must absorb its consequences.

Definition 22.483 (Fast-adjustment capacity). *Fast-adjustment capacity* is the effective ability of an economic position to observe, decide, coordinate, finance, and implement materially relevant change at the characteristic rate of a fast process.

Proposition 22.484 (Fast-adjustment incidence condition). *Where positions differ materially in fast-adjustment capacity, analysis of the fast process should include the distribution of adjustment burdens and the possibility that rapid adaptation by one position displaces risk or cost onto slower positions.*

22.10.2 Slow Variables

Slow-variable research studies conditions whose economically relevant change unfolds over longer horizons relative to a reference process. Infrastructure, organizational culture, legal regimes, skill stocks, demographic structures, ecological capacities, trust, scientific capability, and accumulated debt relations can exhibit slow movement while exerting strong influence over fast activity. Slow variables are therefore analytically important because apparent short-run flexibility can occur inside a slowly changing constraint or capability structure.

Definition 22.485 (Slow variable). A *slow variable* is a measured or reconstructed economic state component whose materially relevant adjustment, accumulation, erosion, or transformation occurs at a characteristic rate substantially longer than the reference process used in the research claim.

Slow change can be hidden by coarse categories. An institution can retain the same formal legal status while implementation routines, personnel, expectations, or enforcement capacity gradually change. An infrastructure can remain operational while maintenance debt accumulates. A community can appear stable while participation, trust, or demographic reproduction erodes. Research should therefore distinguish low observed movement from genuine dynamical persistence.

Definition 22.486 (Latent slow change). *Latent slow change* is cumulative transformation within a provisionally stable category whose effects become visible only after sufficient accumulation, threshold crossing, reclassification, or interaction with another process.

Proposition 22.487 (Slow-variable observability condition). *A slow-variable study should test whether apparent persistence reflects genuine stability, measurement insensitivity, category coarseness, compensating changes, or latent accumulation.*

Slow variables can function as memory. Prior investments, rules, infrastructures, learned routines, or ecological states can store consequences of earlier periods and condition later fast responses. This historical persistence makes slow variables one pathway through which generative spacetime enters contemporary economic behavior.

Definition 22.488 (Slow-state memory). *Slow-state memory* is the persistence of historically accumulated conditions within a slowly changing state component such that earlier events continue to condition current fast processes or later possibilities.

Proposition 22.489 (Slow-state inheritance condition). *Where a slow variable carries material historical inheritance, its empirical specification should record the accumulation, maintenance, erosion, or replacement processes through which that inheritance persists.*

22.10.3 Scale Separation

Scale-separation research asks whether the difference between characteristic rates is sufficiently large and stable that one process can be simplified relative to another without losing the mechanism under study. A fast subsystem can sometimes be treated as rapidly adjusting around a slowly changing condition; a slow subsystem can sometimes be treated as approximately fixed during short-run analysis. Such simplifications can be powerful, but their validity is empirical and local.

Definition 22.490 (Empirical scale separation). *Empirical scale separation* is a research-supported condition in which the characteristic adjustment times of interacting processes differ sufficiently, over a stated domain and horizon, that one process can be approximated as fast relative to another while preserving the mechanism material to the claim.

Where characteristic durations can be estimated meaningfully, a dimensionless comparison can help organize the claim. Let τ_f denote a characteristic adjustment duration of the candidate fast process and τ_s the corresponding duration of the candidate slow process. The ratio $\rho = \tau_f/\tau_s$ can summarize relative separation, but no universal threshold for ρ establishes adequacy. The relevant threshold depends on the coupling mechanism, sampling frequency, intervention horizon, and tolerated approximation error.

Definition 22.491 (Scale-separation warrant). A *scale-separation warrant* records the estimated characteristic rates, uncertainty around those estimates, coupling mechanism, observation horizon, approximation being made, diagnostics supporting that approximation, and conditions under which the approximation should be withdrawn.

Proposition 22.492 (Scale-separation adequacy condition). *A fast-slow decomposition is adequate only over the domain in which the proposed separation preserves the direction, incidence, feedback, and transition possibilities material to the research claim.*

Scale separation can justify averaging or quasi-static approximations, but these operations can remove heterogeneity. Fast fluctuations that average to zero can still generate asymmetric defaults, threshold crossings, or distributional harm. Slow conditions treated as fixed can contain internal variation relevant to vulnerable positions. Research should therefore record what disappears under temporal aggregation.

Definition 22.493 (Temporal-aggregation remainder). A *temporal-aggregation remainder* is the materially relevant information about variation, sequence, extremes, incidence, or threshold crossing lost when a faster process is averaged or a slower process is held fixed for analytical convenience.

Proposition 22.494 (Temporal-aggregation condition). *Scale separation does not justify aggregation where the temporal-aggregation remainder contains events or incidence that materially change the substantive conclusion.*

22.10.4 Breakdown of Scale Separation

A fast-slow representation can lose validity as the system changes. A slow institution can enter rapid reform; a fast market can become frozen; gradual debt accumulation can trigger abrupt deleveraging; ecological degradation can accelerate after a threshold; organizational adaptation can slow under congestion or coordination failure. Research should therefore treat the decomposition as a revisable property of the

observed regime rather than a permanent classification.

Definition 22.495 (Scale-separation breakdown). *Scale-separation breakdown* occurs when changes in characteristic rates, coupling strength, thresholds, constraints, or state dependence make the previous fast–slow decomposition materially inadequate for explanation, prediction, attribution, or intervention.

Definition 22.496 (Rate-regime transition). A *rate-regime transition* is a historically bounded change in which the characteristic rate of one or more processes shifts sufficiently to alter their prior fast–slow relation.

Breakdown can be endogenous. Fast activity can accumulate pressures that accelerate a slow variable, while slow deterioration can change the response time of a fast subsystem. The research problem is therefore to identify precursors and mechanism rather than merely observe that two rates became similar after the fact.

Definition 22.497 (Separation-breakdown precursor). A *separation-breakdown precursor* is an empirically observable change in rate, coupling, recovery, variance structure, constraint, threshold proximity, or state dependence that plausibly indicates declining adequacy of an established fast–slow decomposition.

Proposition 22.498 (Breakdown-monitoring condition). *A research design that relies materially on scale separation should specify diagnostics capable of detecting when the assumed separation weakens or changes regime.*

The literature on critical transitions offers one conditional example. In some dynamical settings, recovery from perturbation can slow as a transition is approached, and changes in autocorrelation or variance can become informative diagnostics (Scheffer et al. 2009). Such indicators should remain mechanism-specific. Similar statistical patterns can arise for other reasons, and many economic transitions do not satisfy the assumptions under which critical-slowness indicators are informative.

Proposition 22.499 (Transition-signal restraint). *Statistical evidence of changing recovery, persistence, or variance supports a breakdown claim only when linked to a plausible rate-changing mechanism and evaluated against competing explanations, sampling effects, and structural change.*

22.10.5 Cross-Frequency Coupling

Cross-frequency research studies how processes operating at different temporal frequencies condition one another. Quarterly funding rules can shape daily organizational decisions; high-frequency trading can influence slower portfolio reallocation; annual budgeting can constrain weekly service provision; long-run demographic change can alter short-run labor adjustment; recurring political or reporting cycles can modulate investment timing. The research object is the coupling mechanism rather than frequency correlation alone.

Definition 22.500 (Cross-frequency coupling). *Cross-frequency coupling* is a mechanism through which the state, phase, amplitude, timing, or transition probability of a process operating at one characteristic frequency materially conditions a process operating at another frequency.

Coupling can be directional, reciprocal, mediated, delayed, intermittent, or state-dependent. A slow policy cycle can modulate fast decisions without receiving immediate feedback; repeated fast decisions can gradually transform the slow institution that constrained them. Research should therefore identify direction and temporal

ordering rather than treating coupling as symmetric by default.

Definition 22.501 (Cross-frequency coupling profile). *A cross-frequency coupling profile records the participating processes, characteristic rates, coupling direction, mediating relation, lag structure, state dependence, persistence, observed signatures, and uncertainty relevant to the proposed interaction.*

Proposition 22.502 (Cross-frequency identification condition). *A cross-frequency claim should distinguish mechanistic coupling from common forcing, coincident periodicity, measurement artifacts, and correlations produced by temporal aggregation.*

Frequency-domain methods can be useful where periodic or quasi-periodic structure is meaningful, but many economic processes are irregular, event-driven, or historically nonstationary. The research programme should therefore allow frequency language to function as one representation among several rather than as a universal transformation of economic time.

Definition 22.503 (Frequency-representation adequacy). *Frequency-representation adequacy is the degree to which a frequency-domain representation preserves the timing, irregularity, nonstationarity, state dependence, and historical structure material to the economic mechanism being studied.*

Proposition 22.504 (Frequency-domain boundary). *Frequency-domain analysis should be supplemented or withdrawn where event order, structural breaks, one-off institutional change, historical branching, or other nonstationary features carry material explanatory content that the frequency representation obscures.*

22.10.6 Synchronization

Synchronization research studies processes whose timing becomes more coordinated through common forcing, institutional design, mutual adjustment, information sharing, technological standards, strategic interaction, or endogenous coupling. Synchronization can reduce uncertainty and support coordination, yet it can also concentrate dependence on common deadlines, settlement windows, reporting cycles, or infrastructure. Its economic significance therefore depends on mechanism and incidence.

Definition 22.505 (Economic synchronization). *Economic synchronization is an increase in consequential temporal alignment among interacting economic processes with respect to phase, timing, update, action window, recurrence, or response pattern over a stated horizon.*

Definition 22.506 (Synchronization mechanism profile). *A synchronization mechanism profile records whether observed alignment arises through common external forcing, direct interaction, institutional coordination, technical standardization, imitation, strategic adaptation, shared information, or another specified pathway.*

Proposition 22.507 (Synchronization attribution condition). *Observed temporal alignment should not be attributed to endogenous coupling until common shocks, common schedules, shared measurement procedures, and other plausible sources of common timing have been considered.*

Synchronization can redistribute fragility. Coordinated liquidity calls, synchronized refinancing, common reporting dates, shared algorithmic responses, or simultaneous inventory adjustment can amplify system-wide pressure even where individual coordination appears efficient. Research should therefore study both coordination benefits and common-mode vulnerability.

Definition 22.508 (Synchronization vulnerability). *Synchronization vulnerability* is the increase in shared exposure, bottleneck dependence, correlated adjustment, or cascade potential produced by consequential temporal alignment among otherwise distinct economic processes.

Proposition 22.509 (Synchronization-incidence condition). *Evaluation of synchronization should record who benefits from temporal coordination, who bears common-mode risk, and whether buffers, redundancy, or staggered timing alter that incidence.*

22.10.7 Desynchronization

Desynchronization research studies divergence in timing, phase, update rate, or response horizon among interacting processes. Desynchronization can arise through institutional mismatch, unequal capacity, geographic dispersion, strategic delay, asynchronous technology, shocks, or deliberate buffering. It can create coordination failure, waiting burden, inventory accumulation, financing gaps, delayed access, or policy ineffectiveness. It can also provide resilience by preventing simultaneous failure and preserving temporal diversity.

Definition 22.510 (Economic desynchronization). *Economic desynchronization* is a materially consequential reduction or absence of temporal alignment among interacting economic processes with respect to phase, timing, cadence, update, or response horizon.

Desynchronization should be distinguished from heterogeneous timescales. Processes can operate at different characteristic rates while remaining well coordinated through buffers or translation mechanisms. Conversely, processes with similar average rates can be persistently out of phase. The research object is consequential mismatch, not difference alone.

Definition 22.511 (Desynchronization incidence profile). *A desynchronization incidence profile* records the processes that are temporally misaligned, the positions affected, the buffering or translation mechanisms available, the resulting delay or burden, and the distribution of adaptive capacity across those positions.

Proposition 22.512 (Desynchronization evidence condition). *A desynchronization claim should establish that temporal mismatch materially affects coordination, access, risk, maintenance, conversion, or later possibility rather than infer harm from temporal difference alone.*

Temporal diversity can be protective. Staggered settlement, diversified review cycles, asynchronous maintenance, and distributed decision authority can reduce correlated failure. Research should therefore identify an empirically relevant coordination envelope rather than assume that maximal synchronization is desirable.

Definition 22.513 (Coordination envelope). *A coordination envelope* is the range of temporal alignment within which interacting processes remain sufficiently coordinated for the stated function while retaining any resilience, autonomy, or buffering benefits of temporal diversity.

Proposition 22.514 (Temporal-diversity condition). *Where partial desynchronization improves resilience or preserves options without materially undermining coordination, the research design should treat temporal diversity as a candidate functional condition rather than as residual noise.*

22.10.8 Empirical Signatures

Empirical-signature research asks what observations would support, weaken, or revise a fast-slow claim. No single indicator establishes fast-slow dynamics across domains. Relevant evidence can include characteristic adjustment times, lagged responses, recovery rates, persistence, spectral concentration, event clustering, phase alignment, threshold-dependent acceleration, structural breaks, cross-frequency dependence, asynchronous burden, and changes in forecast or intervention performance when the decomposition is introduced.

Definition 22.515 (Fast-slow empirical signature). A *fast-slow empirical signature* is an observable pattern whose presence, under stated measurement and modeling assumptions, provides discriminating evidence for or against a specified fast-slow mechanism.

Signatures should be bundled with falsifiers. If a supposed slow variable adjusts as quickly as the fast process after intervention, the decomposition can fail. If cross-frequency association disappears after accounting for common shocks, a coupling claim weakens. If synchronization exists only because data are aggregated to a common reporting interval, substantive alignment remains unestablished.

Definition 22.516 (Fast-slow falsifier profile). A *fast-slow falsifier profile* records observations, alternative mechanisms, rate changes, intervention responses, or robustness failures that would materially weaken the proposed classification, coupling, or scale-separation claim.

Proposition 22.517 (Signature-falsifier pairing condition). A *fast-slow empirical programme* is stronger when each proposed signature is paired with observations or analyses capable of distinguishing the hypothesized mechanism from plausible alternatives.

Sampling design is especially important. A process cannot be characterized reliably at frequencies that the data architecture does not resolve. High-frequency data can improve observation of rapid dynamics while shortening historical depth, increasing noise, or narrowing institutional context. Low-frequency records can reveal slow transformation while aliasing rapid adjustment. Mixed-resolution designs can therefore be preferable.

Definition 22.518 (Temporal sampling adequacy). *Temporal sampling adequacy* is the degree to which observation frequency, historical span, missingness pattern, timestamp precision, and measurement construction permit the characteristic rates and interactions material to a fast-slow claim to be distinguished.

Definition 22.519 (Mixed-resolution design). A *mixed-resolution design* combines evidence collected at different temporal resolutions in order to preserve rapid dynamics, long-run transformation, and the interfaces between them without forcing all processes into one observation interval.

Proposition 22.520 (Empirical-resolution condition). *Where the hypothesized fast and slow processes cannot both be resolved within one data source, inference should combine compatible evidence or narrow the claim rather than infer unobserved rates from a single temporal resolution.*

22.10.9 Limits of the Framework

Fast-slow analysis is a selective representation. Some economic dynamics exhibit a broad continuum of rates rather than two separable classes. Characteristic timescales

can change endogenously, differ across positions, or disappear during crisis. Event-driven processes can resist frequency descriptions. Institutional categories can hide internal rates. Historical transformations can make a decomposition valid in one period and misleading in another. The research programme therefore requires explicit stopping conditions for the framework itself.

Definition 22.521 (Fast–slow framework limit). A *fast–slow framework limit* is a condition under which classification into relatively fast and slow processes materially obscures the mechanism, heterogeneity, historical structure, incidence, or uncertainty required for the research claim.

Definition 22.522 (Timescale continuum). A *timescale continuum* is a configuration in which economically relevant processes occupy a sufficiently broad or dense range of characteristic rates that a binary or small-class fast–slow decomposition lacks stable analytical support.

Proposition 22.523 (Decomposition-withdrawal condition). A *fast–slow decomposition* should be withdrawn, refined, or replaced when its classification ceases to preserve material rate heterogeneity, coupling, incidence, or historical change.

The framework also has normative limits. Faster adjustment is not intrinsically desirable, and slower change is not intrinsically conservative or harmful. Rapid response can intensify extraction, instability, or administrative burden; slow processes can protect continuity, deliberation, ecological regeneration, or rights. Conversely, slow institutions can fail to respond to urgent harm. Evaluation requires a separate account of affected positions, purposes, justice, reversibility, and future options.

Definition 22.524 (Temporal-normative remainder). A *temporal-normative remainder* is the evaluative content concerning burden, benefit, justice, legitimacy, care, rights, ecological requirements, or future possibility that is not determined by identifying a process as fast, slow, synchronized, or desynchronized.

Proposition 22.525 (Fast–slow normative separation). *Descriptive evidence about rate, scale separation, synchronization, or desynchronization does not by itself establish the normative desirability of the observed temporal architecture.*

A mature research programme should therefore maintain a versioned record of the decomposition, its empirical support, its breakdown conditions, and its unresolved remainder. This allows fast–slow analysis to contribute where it clarifies mechanism while retreating when the temporal architecture is better represented through events, continuous spectra, heterogeneous trajectories, institutional histories, or other forms developed elsewhere in GRE.

Definition 22.526 (Fast–slow research ledger). A *fast–slow research ledger* records the candidate fast and slow processes, timescale-reference profiles, separation warrants, coupling mechanisms, empirical signatures, falsifiers, breakdown diagnostics, normative remainders, and framework-limit conditions associated with a research programme.

Proposition 22.527 (Fast–slow research boundary). *Fast–slow economic analysis is adequate where differentiated rates and their interactions materially improve explanation, comparison, or intervention while remaining empirically supported and revisable; it should yield to another temporal representation where the decomposition no longer earns that role.*

The next research problem shifts from temporal architecture to asymmetry and realized influence. Fast–slow relations can contribute to power when some positions

can act, revise, wait, or impose temporal conditions at rates unavailable to others, yet power cannot be reduced to temporal advantage. The following section therefore develops a dedicated research programme for economic power across resources, capabilities, relations, institutions, epistemic positions, conversion interfaces, circulation pathways, capture, and persistent asymmetry.

22.11 Research on Economic Power

The role of this section is to convert the book's earlier conceptual account of economic power into a research programme capable of distinguishing power from asymmetry, inequality, advantage, centrality, authority, and realized outcomes. The objective is to specify how different forms of power can be identified, compared, traced historically, and challenged empirically without reducing them to a single scalar. The discussion proceeds through resource, capability, relational, epistemic, institutional, conversion, circulation, and capture power before examining persistence under long-lived asymmetry. The method is mechanism-centered and empirically plural. Administrative records, contracts, transaction data, network data, organizational records, interviews, ethnography, legal materials, experiments, process tracing, longitudinal data, historical reconstruction, counterfactual analysis, and formal models can each contribute where they identify a credible pathway through which one position conditions another position's feasible action, access, relations, value processes, or future options.

Power research in GRE begins with a discipline of attribution. A difference in resources, capabilities, information, institutional standing, relational position, temporal flexibility, or access can be power-relevant, yet the difference alone does not establish power. The research claim becomes stronger when the inquiry identifies dependence, a usable conditioning mechanism, constrained alternatives, and retained consequences for another position. Power can also remain latent, operate through distributed arrangements, or persist after its original carrier changes. Research design should therefore distinguish the carrier of power, the mechanism through which it operates, the manifestation through which it becomes observable, and the consequence through which it is inferred.

Definition 22.528 (Economic-power research object). An *economic-power research object* is a historically situated relation or coupled configuration in which a specified position is hypothesized to possess a practically effective capacity to condition another position's feasible action, access, capabilities, relations, value processes, or future trajectories through an identifiable mechanism.

Definition 22.529 (Power-identification dossier). A *power-identification dossier* records the candidate carrier, affected position, relevant asymmetry, dependence structure, conditioning mechanism, effective alternatives, time horizon, scale, observable manifestations, persistence conditions, contestability, and plausible competing explanations for a power claim.

Definitions 22.528 and 22.529 specify the research object and the common evidential architecture for the forms developed below. It also keeps the inquiry open to disconfirmation. A candidate power relation can weaken when substitution becomes feasible, when institutional enforcement fails, when recognition changes, when alternative infrastructures emerge, or when a supposed mechanism proves epiphenomenal.

Proposition 22.530 (Asymmetry–power identification condition). *An observed asymmetry supports an economic-power claim only when evidence connects the asymmetry to a practically effective conditioning mechanism under the alternatives, horizon, and scale relevant to the affected position.*

Proposition 22.530 prevents power analysis from becoming a synonym for inequality analysis. The same distribution can support different power relations depending on dependence and institutional context, while comparatively small differences can become highly consequential when they control a bottleneck or irreplaceable interface.

Table 22.11 summarizes the principal research domains developed in this section.

22.11.1 Resource Power

Research on resource power studies conditions under which control, command, or reliable access to consequential resources becomes a practical capacity to condition another economic position. The relevant resource can be financial, material, spatial, infrastructural, legal, organizational, or informational when it functions principally through selective provision, withholding, pricing, collateralization, buffering, or allocation. The research task is to reconstruct how the resource position becomes usable within the relation rather than infer power from resource inequality alone.

Definition 22.531 (Resource-power identification profile). *A resource-power identification profile records the consequential resource, control or access relation, affected dependence, deployable quantity or quality, withholding or allocation mechanism, effective substitutes, switching cost, buffering capacity, and time horizon over which the resource position can condition another position.*

Definition 22.531 separates resource possession from resource deployability. Assets can be legally restricted, illiquid, technically incompatible, politically costly to use, or irrelevant to the dependence at issue. Conversely, a comparatively modest resource can generate strong conditioning capacity where alternatives are scarce and interruption is costly.

Proposition 22.532 (Resource-stock non-equivalence). *A larger resource stock does not by itself establish greater resource power; the research claim should identify the pathway through which the resource can be deployed to alter another position’s practical alternatives or costs.*

Definition 22.533 and Proposition 22.532 make resource power mechanism-dependent. Empirical designs can therefore compare nominal holdings with actual command, drawdown rights, access restrictions, liquidity, delivery capacity, and the consequences of withdrawal or repricing.

Definition 22.533 (Resource-leverage profile). *A resource-leverage profile records how changes in provision, withholding, price, collateral, timing, quantity, or quality of a consequential resource alter the affected position’s feasible action under stated substitution conditions.*

Proposition 22.534 (Substitution-horizon condition). *Resource power should be evaluated against alternatives that are practically reachable within the horizon before the relevant loss or constraint becomes consequential.*

The substitution discipline in Proposition 22.534 is especially important for credit, housing, energy, healthcare, specialized inputs, emergency finance, and other settings

Table 22.11: Principal research domains in economic power

Research main	do-	Primary object	Principal evidential burden
Resource power		Control, command, or reliable access to consequential resources	Establish deployability, dependence, withholding or allocation mechanism, substitution conditions, and horizon
Capability power		Scarce or differentially effective capacities on which others materially rely	Identify effective capability, complementarity, recognition, replaceability, and time to substitution or learning
Relational power		Gatekeeping, brokerage, connection, disconnection, and control over relation formation or continuation	Distinguish practical conditioning capacity from network centrality, visibility, or connectedness alone
Epistemic power		Knowledge, data, evidence, classification, measurement, validation, or recognized interpretive authority	Trace the pathway from epistemic position to consequential uptake, access, classification, or agenda formation
Institutional power		Rule competence, mandate, procedure, office, enforcement, eligibility, or recognized authority	Establish implementation, discretion, compliance, enforcement, procedural incidence, and effective review
Conversion power		Control over interfaces through which resources, capacities, claims, or value forms become convertible or recognizable	Identify gatekeeping, terms setting, admissibility, rate or quality conditions, alternatives, and conversion incidence
Circulation power		Control over routing, priority, retention, delay, intermediation, blockage, or return pathways	Establish how pathway control changes access, timing, reach, incidence, or feasible downstream circulation
Capture power		Capacity to appropriate, retain, or redirect a disproportionate share of generated or circulating value	Distinguish latent appropriation capacity from realized capture and identify the claim, rule, interface, or residual-control mechanism
Persistent asymmetry	asym-	Long-lived configurations through which power-supporting asymmetries are reproduced or adaptively retained	Identify reproduction pathways, successor structures, counter-power, dissolution conditions, and historical discontinuities

where a nominal substitute can exist while remaining unreachable in time. Research should record both the alternative and the time, cost, permission, compatibility, or coordination required to reach it.

Definition 22.535 (Resource-buffer asymmetry). *Resource-buffer asymmetry* is a difference between positions in the capacity to absorb interruption, delay, price change, loss, or uncertainty through reserves, inventories, diversification, insurance, slack, or other buffering resources.

Proposition 22.536 (Buffering-power condition). *Resource-buffer asymmetry becomes power-relevant when unequal endurance materially changes bargaining, timing,*

exit, or access conditions for another position rather than merely changing the holder's private risk exposure.

Definition 22.535 and Proposition 22.536 direct empirical attention toward endurance and waiting capacity rather than stocks alone. A strong research design can therefore combine balance-sheet or inventory data with event histories, contract timing, negotiation records, and observed responses to interruption.

22.11.2 Capability Power

Capability power concerns practically effective capacities that other positions materially need for production, coordination, interpretation, protection, maintenance, conversion, or access. Expertise, organizational competence, technical skill, legal capacity, logistical coordination, repair ability, and trusted judgment can each support power where the capability is consequential and difficult to replace. The research task is to distinguish scarce capability from capability power by identifying dependence and the pathway through which selective exercise conditions others.

Definition 22.537 (Capability-power identification profile). *A capability-power identification profile records the effective capability, tasks or outcomes dependent on it, quality threshold, complementary resources, recognition conditions, number and location of substitutes, time to replacement or learning, and the consequences of selective exercise or withdrawal.*

Proposition 22.538 (Capability-difference non-equivalence). *A capability difference supports a power claim only where another position's relevant activity or future options materially depend on access to that capability under the available alternatives.*

Definition 22.537 and Proposition 22.538 make capability power sensitive to quality and complementarity. A capability can be rare while economically peripheral, or widely distributed while one recognized provider retains power because institutional rules privilege its certification or authorization.

Definition 22.539 (Capability-replaceability horizon). *A capability-replaceability horizon is the time and supporting-resource interval required for an affected position to acquire, train, hire, coordinate, recognize, or otherwise reach an effective alternative to a power-relevant capability.*

Proposition 22.540 (Learning-dilution condition). *Where capability formation is feasible, evidence of declining replacement time or widening effective provision should weaken claims of persistent capability power unless another mechanism preserves dependence.*

Definition 22.539 and Proposition 22.540 make capability power dynamically testable. Longitudinal research can examine whether training, codification, automation, organizational learning, interoperability, or professional diffusion erodes the relevant dependence, or whether recognition rules and complementary infrastructure preserve it.

Definition 22.541 (Capability-bottleneck profile). *A capability-bottleneck profile records a capability whose scarcity, complementarity, sequencing position, or quality threshold constrains completion of a wider economic process despite the availability of other inputs.*

Proposition 22.542 (Bottleneck-power condition). *A capability bottleneck becomes power-relevant when control over the bottleneck permits a position to condition terms,*

timing, access, or continuation for positions that cannot bypass or replace the capability within the relevant horizon.

Definition 22.541 and Proposition 22.542 are useful for research on specialized professions, key technical staff, repair systems, organizational knowledge, and high-complementarity production. It also directs attention toward collective capability: a team, community, institution, or distributed network can hold a capability that no single member possesses independently.

22.11.3 Relational Power

Relational power is carried principally by position within relations or higher-order relational configurations. Brokerage, gatekeeping, matching, connection, disconnection, membership, intermediation, and control over relation formation can condition economic opportunity without ownership of the resources exchanged. Research in this domain should combine structural description with process evidence showing that relational position is practically used or embedded in a mechanism that changes another position's feasible connections.

Definition 22.543 (Relational-power identification profile). *A relational-power identification profile records the relevant network or relational configuration, gatekeeping or brokerage position, controlled relation-formation process, affected positions, alternative pathways, switching or reconnection costs, and evidence that the position materially changes access, matching, coordination, or continuation.*

Proposition 22.544 (Centrality–power non-equivalence). *Network centrality, connectedness, or visibility does not establish relational power unless the measured position is linked to a mechanism through which another position's practical relational possibilities are conditioned.*

Definition 22.543 and Proposition 22.544 place a strong evidential boundary around network metrics. Degree, betweenness, prestige, or structural-hole measures can be useful manifestations, yet the power claim requires a mechanism connecting the measure to gatekeeping, brokerage, access, sequencing, or another consequential relational process.

Definition 22.545 (Gatekeeping reach). *Gatekeeping reach* is the set of positions, relations, opportunities, or downstream processes whose practical accessibility can be altered by a gatekeeping position under a stated institutional and temporal context.

Definition 22.546 (Brokerage substitutability). *Brokerage substitutability* is the availability and practical accessibility of alternative intermediaries, direct links, protocols, or institutional routes capable of performing the economically relevant connection function.

Proposition 22.547 (Relational-power substitutability condition). *A relational-power claim should weaken as brokerage substitutability increases, unless the candidate position controls another mechanism that preserves practical dependence despite nominal alternative connections.*

Definitions 22.545 and 22.546, together with Proposition 22.547, allow comparative work across labor markets, supply chains, finance, platforms, procurement, scientific collaboration, migration networks, and professional communities. Research should also examine disconnection power: exclusion, deplatforming, delisting, termination, or refusal to connect can be as consequential as brokerage itself.

Definition 22.548 (Relational-switching burden). A *relational-switching burden* is the material, informational, temporal, reputational, institutional, or coordination cost borne when an affected position attempts to leave a power-relevant relation and establish an alternative one.

Proposition 22.549 (Relational-switching condition). *Nominal availability of alternative relations should not be treated as effective counter-power where relational-switching burdens make those alternatives materially inaccessible within the relevant horizon.*

Definition 22.548 and Proposition 22.549 therefore require empirical research to measure the practical cost and timing of reconnection rather than count nominal alternatives alone.

22.11.4 Epistemic Power

Epistemic power concerns knowledge, data, evidence, measurement, classification, validation, prediction, agenda formation, and recognized interpretive authority where these epistemic positions condition economic access or action. Research should distinguish information advantage from power. Private knowledge that does not affect another position's feasible action can remain advantageous without becoming an effective conditioning mechanism. Epistemic power becomes more plausible where classifications, evidence standards, rankings, forecasts, or authoritative interpretations determine eligibility, credibility, resource access, or institutional response.

Definition 22.550 (Epistemic-power identification profile). An *epistemic-power identification profile* records the knowledge or evidential resource, recognition status, production and access conditions, classification or validation process, decision interface, affected positions, opportunities for contestation, and consequences of epistemic uptake or exclusion.

Proposition 22.551 (Knowledge-difference non-equivalence). *A difference in information, expertise, or predictive accuracy supports an epistemic-power claim only where an identifiable uptake pathway converts the difference into consequential control over access, classification, agenda, interpretation, or decision.*

Definition 22.550 and the uptake requirement in Proposition 22.551 are critical for empirical design. Researchers can trace how scores, classifications, audits, diagnoses, rankings, professional judgments, and data models enter decisions and whether decision makers can disregard or override them.

Definition 22.552 (Classification-to-action pathway). A *classification-to-action pathway* is the sequence through which an epistemic category or measurement changes eligibility, treatment, priority, access, burden, or another economically consequential response.

Definition 22.553 (Validation dependency). *Validation dependency* is reliance on a specified actor, organization, instrument, data source, credential, or epistemic procedure for a claim, identity, qualification, or condition to become institutionally or economically actionable.

Proposition 22.554 (Validation-power condition). *Validation dependency becomes power-relevant when the validating position can materially condition recognition or access and affected positions lack timely, credible, and effective alternative validation*

routes.

Definitions 22.552 and 22.553, together with Proposition 22.554, are especially useful for studying credit scoring, professional certification, scientific expertise, auditing, identity systems, platform rankings, and administrative eligibility. The analysis should record error correction, appeal, transparency, and alternative evidence because these features can reduce or redistribute epistemic power.

Definition 22.555 (Epistemic contestability profile). An *epistemic contestability profile* records the affected position's access to reasons, underlying evidence, correction procedures, alternative experts, appeal channels, and effective opportunities to challenge a consequential epistemic judgment.

Proposition 22.556 (Contestability-counterpower condition). *Effective epistemic contestability can function as counter-power when it can alter, suspend, review, or bypass a consequential classification or validation rather than merely permit expression of disagreement.*

Definition 22.555 and Proposition 22.556 make contestability an observable institutional property rather than a purely formal right.

22.11.5 Institutional Power

Institutional power is carried by office, mandate, rule competence, procedure, recognized authority, enforcement capacity, eligibility control, or organizational role. Formal authority supplies an important manifestation, yet practical power depends on implementation, compliance, discretion, sequencing, and the availability of review or alternative institutions. Research should therefore reconstruct both the institutional rule and the material pathway through which the rule becomes effective.

Definition 22.557 (Institutional-power identification profile). An *institutional-power identification profile* records the office or institutional position, mandate, rule competence, discretionary range, enforcement resources, procedural sequence, affected positions, compliance conditions, review architecture, and evidence of practical conditioning capacity.

Proposition 22.558 (Formal-authority non-equivalence). *Formal legal or organizational authority does not establish effective institutional power where implementation, enforcement, compliance, coordination, or recognition is materially absent.*

Definition 22.557 and Proposition 22.558 invite empirical comparison between written rules and enacted practice. Administrative data, enforcement records, implementation studies, organizational ethnography, court decisions, contracts, and interviews can reveal whether nominally authoritative positions can actually condition behavior or access.

Definition 22.559 (Institutional-discretion profile). An *institutional-discretion profile* records the range within which an institutional position can interpret, prioritize, waive, sequence, classify, enforce, or otherwise implement rules without requiring a new formal rule.

Proposition 22.560 (Discretion-power condition). *Institutional discretion becomes power-relevant when variation within the permitted range materially changes another position's access, burden, timing, standing, or future options and the affected position cannot readily neutralize that variation.*

Definition 22.559 and Proposition 22.560 also support comparative work on

discretion-limiting arrangements. Standardization, reasons requirements, independent review, transparent criteria, distributed authority, and appeal can reduce some forms of institutional power while shifting power toward rule designers, auditors, or reviewing bodies.

Definition 22.561 (Procedural-sequencing power). *Procedural-sequencing power* is institutional power exercised through control over the order, timing, prerequisite structure, or admissibility of procedural steps whose sequence materially conditions later economic possibilities.

Proposition 22.562 (Procedure–outcome pathway condition). *A procedural-power claim should identify how control of sequence or admissibility changes a consequential outcome or option set rather than infer power from procedural complexity alone.*

Definition 22.561 and Proposition 22.562 provide the corresponding empirical test for sequencing claims.

22.11.6 Conversion Power

Conversion power concerns control over interfaces through which resources, capabilities, claims, statuses, or value forms become transformable into economically effective outcomes. Section 22.6 developed conversion as a typed mechanism with conditions, rates, nonlinearities, losses, gains, and failures. The present subsection asks who can shape those conditions. Conversion power can operate through certification, pricing rules, exchange terms, interoperability requirements, credential recognition, payment systems, procurement standards, legal recognition, or access to complementary infrastructure.

Section 22.6 already defined conversion power in Definition 22.286. The present research programme treats that concept as an object for identification and comparison rather than redefining it. An interface controller can possess latent power even when few conversions occur, while frequent conversion can occur through an open and contestable interface with limited concentrated power.

Definition 22.563 (Conversion-power research profile). *A conversion-power research profile* records the interface controller, source and target forms, admissibility rules, term-setting authority, quality thresholds, recognition conditions, complementary dependencies, alternative interfaces, review pathways, and incidence of interface decisions.

Definition 22.564 (Conversion-control profile). *A conversion-control profile* records the interface controller, source and target forms, admissibility rules, term-setting authority, quality thresholds, recognition conditions, complementary dependencies, alternative interfaces, appeal or review, and incidence of interface decisions.

Proposition 22.565 (Conversion-volume non-equivalence). *High conversion volume does not establish conversion power; power attribution requires evidence that a position can materially condition the terms or practical accessibility of conversion for affected positions.*

Definition 22.566 (Conversion-term power). *Conversion-term power* is the capacity to set or materially influence the price, rate, recognition threshold, procedural burden, quality standard, timing, residual claim, or other condition governing a consequential conversion interface.

Proposition 22.567 (Conversion-alternative condition). *A conversion-term power*

claim should be evaluated against effective alternative conversion pathways, including their compatibility, cost, timing, recognition, and downstream acceptance.

Definitions 22.563, 22.564, and 22.566 specify the principal research records for interface control. Propositions 22.565 and 22.567 set the corresponding comparative boundaries. Together they support empirical research on credentials, payment systems, procurement, financial intermediation, platform standards, professional licensing, intellectual-property regimes, and other interfaces where value realization depends on recognized transformation. Such studies should distinguish institutional, epistemic, infrastructural, and conversion mechanisms even when they are carried by the same organization.

Definition 22.568 (Conversion-interface contestability). *Conversion-interface contestability* is the practical capacity of affected positions to challenge, bypass, substitute, collectively renegotiate, or obtain review of the rules and terms governing a consequential conversion interface.

Proposition 22.569 (Conversion-contestability counter-power). *Conversion-interface contestability reduces concentrated conversion power only to the extent that challenge or substitution can materially alter conversion access or terms within the relevant horizon.*

Definition 22.568 and Proposition 22.569 identify the counter-power side of conversion-interface research.

22.11.7 Circulation Power

Circulation power concerns control over the pathways through which value, resources, information, rights, obligations, recognition, or other economically consequential states move among positions. Section 22.7 developed circulation pathways, cross-domain and cross-scale movement, recurrence, dissipation, capture, regeneration, and transfer incidence. The present subsection studies how routing, priority, delay, retention, intermediation, blockage, and return-path control become power mechanisms.

Definition 22.570 (Circulation power). *Circulation power* is economic power whose principal conditioning mechanism arises from control over the routing, priority, timing, retention, intermediation, blockage, reach, or return pathway of an economically consequential circulation process.

Definition 22.571 (Circulation-control profile). A *circulation-control profile* records the circulated object or state, pathway topology, controlling position, routing or priority rule, bottlenecks, delay and retention capacity, affected positions, alternative routes, and downstream incidence.

Definitions 22.570 and 22.571, together with Proposition 22.572, allow research to separate simple network position from power over actual flow. A highly connected intermediary can lack discretion, while a technically minor node can exert substantial control if all admissible routes pass through it.

Proposition 22.572 (Flow-volume non-equivalence). *The volume of value or resources passing through a position does not by itself establish circulation power; the inquiry should identify discretionary or structurally embedded control over routing, timing, retention, priority, or blockage.*

Definition 22.573 (Routing-power profile). A *routing-power profile* records how a po-

sition can direct circulation toward, away from, through, or around specified nodes, domains, scales, or populations and the consequences of alternative routing decisions.

Definition 22.574 (Circulation-delay power). *Circulation-delay power* is a capacity to postpone, accelerate, queue, settle, release, or otherwise time a circulation process in ways that materially alter another position's costs, access, liquidity, recognition, or future options.

Proposition 22.575 (Delay-power incidence condition). *A circulation-delay claim should identify the positions bearing the consequences of altered timing and distinguish discretionary delay from technical latency, congestion, or common external disruption.*

Definitions 22.573 and 22.574, together with Proposition 22.575, make circulation power closely connected to temporal power while retaining a distinct object: the timing of a circulating state rather than temporal capacity in general. Similar distinctions apply to return pathways. Control over whether revenues, data, credit, knowledge, or other value returns to source relations can create a power mechanism even where initial circulation remains open.

Definition 22.576 (Return-path power). *Return-path power* is circulation power exercised through control over whether, when, in what form, and through which route value or resources can return to contributors, source relations, communities, infrastructures, or other regenerative targets.

Proposition 22.577 (Return-path research condition). *A return-path power claim should distinguish control over circulation from evidence that the resulting return is generative, just, or normatively adequate.*

Definition 22.576 and Proposition 22.577 preserve the boundary between circulation control and the evaluative questions developed in adjacent sections.

22.11.8 Capture Power

Capture power concerns the capacity to appropriate, retain, redirect, or secure a disproportionate claim on value generated across relations. Realized capture is an outcome; capture power is the preceding or persistent capacity that makes such appropriation possible. The distinction matters empirically because a position can possess substantial capture power during periods in which it chooses not to exercise it, while observed concentration can arise from production, risk bearing, prior ownership, or other mechanisms that require separate evaluation.

Definition 22.578 (Capture power). *Capture power* is economic power whose principal conditioning mechanism arises from a position's practically effective capacity to appropriate, retain, redirect, or secure claims over value, returns, residuals, rents, data, rights, or other economically consequential outputs generated through a wider relational process.

Definition 22.579 (Capture-power identification profile). *A capture-power identification profile* records the generated value or output, contribution architecture, claim basis, appropriation mechanism, residual-control rights, interface or rule carrying the claim, affected contributors, alternatives, contestability, and observed or counterfactual capture incidence.

Proposition 22.580 (Capture-power–capture-outcome distinction). *Observed value capture does not by itself establish capture power, and absence of current capture does*

not establish absence of capture power; the research claim should identify the capacity and mechanism through which appropriation can be conditioned.

Definitions 22.578 and 22.579, together with Proposition 22.580, permit researchers to distinguish realized extraction from latent bargaining or residual-control capacity. Counterfactual evidence can be relevant where contracts, platform rules, intellectual-property rights, ownership structures, fee schedules, or institutional privileges reveal appropriation capacity even during low-usage periods.

Definition 22.581 (Residual-control capture). *Residual-control capture* is capture enabled by authority over uses, claims, or outputs not completely specified ex ante in a contract, rule, or allocation arrangement.

Proposition 22.582 (Residual-control identification condition). *Residual-control capture should be attributed only where the residual authority is both practically exercisable and connected to appropriation or redirection of value generated by the relevant relational process.*

Definition 22.581 and Proposition 22.582 provide a narrower test for capture claims grounded in residual authority.

Definition 22.583 (Capture-point profile). A *capture-point profile* records the location in a production, conversion, circulation, return, or institutional pathway at which a position can intercept, redirect, retain, or claim value and the alternatives available to affected positions before and after that point.

Proposition 22.584 (Capture-point relocation condition). *Where regulation, technology, collective action, or organizational change removes one capture point, research should examine whether appropriation capacity is reduced, displaced to another interface, or transformed into another form of power.*

Definition 22.583 and Proposition 22.584 make capture research dynamic. A fee can disappear while data control expands; direct ownership can weaken while standard-setting power grows; formal rents can decline while conversion or circulation power creates a new appropriation pathway. The research object is therefore the evolving architecture of capture capacity rather than one observed payment stream.

22.11.9 Power under Persistent Asymmetry

Research on persistent asymmetry asks how power relations endure, reproduce, adapt, weaken, or dissolve over historical time. Persistence is analytically stronger than repeated observation of inequality. A power relation can reproduce itself through resource accumulation, capability formation, dependency, gatekeeping, classification, institutional rules, infrastructure, conversion interfaces, circulation control, capture, intergenerational transmission, or combinations of these mechanisms. It can also persist adaptively when the carrier changes while the directional conditioning role remains.

Definition 22.585 (Persistent power configuration). A *persistent power configuration* is a historically connected sequence of relational arrangements in which a specified directional conditioning capacity remains materially effective over the research horizon despite ordinary variation in manifestations, participants, or supporting mechanisms.

Proposition 22.586 (Persistence–repetition non-equivalence). *Repeated asymmetry or repeated unequal outcomes support a persistent-power claim only when the inquiry*

identifies a continuity or reproduction mechanism linking the observations across time.

Definition 22.585 and Proposition 22.586 permit disciplined study of both literal and adaptive persistence. The continuity criterion should be declared: the same organization can remain while the mechanism changes, or a successor organization can preserve a role-equivalent conditioning position after the original carrier disappears.

Definition 22.587 (Power-reproduction profile). A *power-reproduction profile* records the mechanisms through which a power-supporting asymmetry is renewed across time, including accumulation, dependency formation, gatekeeping, classification, institutional reproduction, infrastructure, conversion control, circulation control, capture, succession, and intergenerational transmission where relevant.

Proposition 22.588 (Reproduction-mechanism condition). *A claim of self-reinforcing power should identify how the exercise or effects of power alter later conditions in a direction that supports continuation of the relevant power relation rather than infer self-reinforcement from durability alone.*

Definition 22.587 and Proposition 22.588 direct research toward feedback. Resource power can finance institutional influence; institutional power can define conversion interfaces; conversion power can generate capture; capture can expand resources; epistemic power can stabilize classifications that legitimate institutional rules. The cycle remains an empirical hypothesis until the connecting mechanisms are supported.

Definition 22.589 (Adaptive power persistence). *Adaptive power persistence* occurs when historically connected successor structures preserve a specified directional conditioning role while one or more carriers, manifestations, or supporting mechanisms change.

Proposition 22.590 (Adaptive-persistence evidence). *An adaptive-persistence claim should specify the role-equivalence criterion linking predecessor and successor structures and preserve evidence of material discontinuities rather than treating similarity of outcome as sufficient continuity.*

Definition 22.589 and Proposition 22.590 allow historical studies to trace power across institutional redesign, technological change, organizational succession, or legal reform while avoiding a claim that all similar inequalities instantiate one unchanged structure.

Definition 22.591 (Counter-power profile). A *counter-power profile* records positions, institutions, collective capacities, alternative resources, exit routes, review mechanisms, technical substitutes, or relational arrangements capable of constraining, redistributing, bypassing, or dissolving a specified power mechanism.

Proposition 22.592 (Power-dissolution condition). *Evidence that dependence, conditioning capacity, persistence, or effective alternatives have materially changed should trigger revision or withdrawal of the corresponding power claim even where historical inequality remains visible.*

Definition 22.591 and Proposition 22.592 make dissolution a first-class research object. Institutional reform, interoperability, shared infrastructure, collective organization, training, open standards, portability, public provision, alternative validation, and new technologies can each weaken particular power mechanisms while potentially creating others.

Definition 22.593 (Longitudinal power ledger). A *longitudinal power ledger* is a versioned research record that tracks the identified power form, carrier, affected po-

sitions, mechanism, evidence, alternatives, reproduction pathways, counter-power, structural breaks, and claim-status revisions across time.

Proposition 22.594 (Longitudinal revision condition). *A persistent-power research programme should revise the longitudinal power ledger when new evidence changes the identified carrier, mechanism, domain, horizon, reproduction pathway, counter-power, or continuity criterion.*

Definition 22.593 and Proposition 22.594 close the section by linking power research to the open-programme discipline established earlier in Chapter 22. Resource, capability, relational, epistemic, institutional, conversion, circulation, and capture power can be studied separately where the mechanisms are distinct and jointly where they compose. Their empirical identification remains separate from normative judgment. The next section therefore turns to justice in generative economies, where the distribution, legitimacy, recognition, participation, historical formation, and future consequences of these power relations become explicit objects of evaluation.

22.12 Research on Justice in Generative Economies

The role of this section is to convert the book's substantive justice architecture into a research programme capable of reconstructing justice-relevant economic conditions, making normative premises explicit, and testing the descriptive and causal claims on which normative evaluation depends. Chapter 16 developed distributional, relational, generative, historical, and relation-variation dimensions of justice, while Sections 22.5–22.11 developed research programmes for heterogeneous value, conversion, circulation, return, generative spacetime, fast–slow dynamics, and economic power. The objective here is to specify how those objects can be investigated without collapsing normative judgment into measurement or treating empirical description as normatively self-interpreting. The discussion proceeds through distributional justice, relational justice, generative opportunity, historical and intergenerational justice, conversion and circulation justice, incommensurable values, heterogeneous subjects, and transfer justice. The method is normatively explicit and empirically plural. Distributional statistics, administrative records, longitudinal data, causal inference, process tracing, institutional analysis, legal and policy interpretation, interviews, ethnography, participatory inquiry, historical reconstruction, archival research, comparative theory, and formal models can each contribute when their inferential role and normative dependence are stated.

Justice research in GRE has two coupled tasks. One task reconstructs the economic configuration: which resources, capabilities, relations, burdens, risks, conversion interfaces, circulation pathways, historical inheritances, and future possibilities are distributed across which positions, by which mechanisms, and over what horizon. The other task makes the evaluative basis visible: which claims of equality, sufficiency, rights, need, recognition, reciprocity, non-domination, participation, repair, sustainability, contribution, care, or future standing are doing normative work. These tasks should remain distinguishable because stronger empirical evidence cannot by itself resolve a disagreement whose decisive premise is normative, while a compelling normative principle can be misapplied when the underlying incidence or mechanism has been reconstructed incorrectly.

Definition 22.595 (Justice-research profile). *A justice-research profile* is a structured

record of the affected positions, justice-relevant economic objects, spatial and temporal scope, descriptive incidence, causal or generative mechanisms, historical conditions, power relations, practical alternatives, normative principles, evidential basis, uncertainty, disagreement, and revision conditions used to support a scoped justice claim.

Definition 22.596 (Normative-premise register). A *normative-premise register* records the principles, standing assumptions, comparison rules, thresholds, priority relations, aggregation rules where used, and unresolved normative disagreements through which a reconstructed economic configuration is evaluated.

Definitions 22.595 and 22.596 create a common evidential and normative architecture for the research domains developed below. They also permit disagreement to be located more precisely. Two studies can agree about the distribution of burdens while disagreeing about the appropriate principle of priority; they can share a normative principle while disagreeing about whether a conversion loss is voluntary, avoidable, or historically produced; or they can diverge because one study omits affected positions that another study identifies through broader incidence tracing.

Proposition 22.597 (Descriptive–normative separation condition). A *justice claim* should distinguish the descriptive and causal propositions used to reconstruct the economic configuration from the normative premises used to evaluate that configuration, while also recording the points at which the two depend on one another.

Proposition 22.597 does not imply that description is value-free or that normative inquiry can proceed without interpretation. Classification, measurement, boundary selection, and choice of affected positions can carry normative significance. The proposition requires the research record to expose those dependencies rather than allow them to remain implicit.

Table 22.12 summarizes the principal domains developed in this section.

22.12.1 Distributional Justice

Distributional-justice research begins with the multidimensional distributional architecture developed in Chapter 16's analysis of distribution and generativity. Income, wealth, and commodities remain important objects, yet GRE also permits justice-relevant distributions of capability, access, participation, relational opportunity, protection, burden, temporal flexibility, and future possibility. The research task is therefore to identify the object being distributed, the positions among which comparison is made, the mechanisms through which the object becomes practically consequential, and the normative rule under which the pattern is evaluated.

A central empirical problem is conversion between distributional dimensions. Equal nominal transfers can yield unequal effective capacities where recipients face different costs, institutional barriers, care burdens, accessibility conditions, recognition, or infrastructure. Unequal inputs can also support more similar effective capabilities where differentiated provision compensates for unequal conversion conditions. Research should therefore preserve both the initial distribution and the mechanism through which it becomes another justice-relevant distribution.

Definition 22.598 (Distributional-justice research profile). A *distributional-justice research profile* records the distributed object, affected positions, unit and scale of comparison, temporal horizon, baseline or counterfactual where relevant, conversion

Table 22.12: Principal research domains in justice within generative economies

Research domain	Primary object	Principal research burden
Distributional justice	Resources, capabilities, access, burdens, participation, and future possibility	Preserve object, unit, horizon, conversion conditions, and comparison rule
Relational justice	Recognition, authority, dependence, reciprocity, contestability, and exit	Distinguish formal terms from practical accessibility and consequential effect
Generative opportunity	Later capacity, relation formation, and usable option spaces	Identify mechanism, complementary conditions, horizon, expansion, and foreclosure
Historical justice	Transmitted harm, advantage, constraint, claims, and repair	Establish continuity, provenance, responsibility, and remedy incidence
Intergenerational justice	Transmitted capacities, burdens, infrastructures, and ecological conditions	Trace transmission, persistence, reversibility, and representation of future standing
Conversion justice	Terms of conversion among resources, claims, statuses, capacities, and value forms	Identify control, eligibility, losses, alternatives, burdens, and review
Circulation justice	Pathways of movement, recurrence, capture, return, and regeneration	Trace route, intermediation, burden, governance, and downstream incidence
Incommensurable values	Values lacking a justified common metric	Preserve value types, thresholds, partial comparisons, residual loss, and disagreement
Heterogeneous subjects	Positions with differing capacities, needs, temporal standing, and participation modes	Specify standing, representation, accommodation, and limits of proxy evidence
Transfer justice	Discrete or staged movements and their wider incidence	Trace conditions, timing, intermediation, dependency, return, and feasible alternatives

conditions, burdens and protections, resulting capabilities or opportunities, and the normative principle used to evaluate the distribution.

Definition 22.598 supports studies in which different distributional objects are deliberately kept separate. A study can compare income inequality, effective access, capability, exposure to risk, and future option distributions without presuming that one is an adequate proxy for the others.

Proposition 22.599 (Distribution-object stability condition). *A distributional-justice comparison should preserve the identity of the distributed object across the comparison or explicitly model the conversion through which one object is used to infer another.*

Proposition 22.599 disciplines common inferential shortcuts. Formal eligibility cannot be used as evidence of equal practical access without a conversion argument; equal expenditure does not establish equal service quality; equal current resources do not establish equal future possibility; and equal participation rights do not establish equal influence where the relevant capacities and burdens differ materially.

A second research problem concerns aggregation. A national, regional, organizational, household, or community distribution can conceal substantial internal heterogeneity. Justice research should therefore identify the scale at which an aggregate is normatively relevant and test whether subgroup, relational, or within-unit distributions alter the inference. Multilevel models, decomposition methods, matched comparisons, qualitative reconstruction, and affected-position testimony can be combined where no single scale adequately represents incidence.

Definition 22.600 (Distributional aggregation sensitivity). *Distributional aggregation sensitivity* is the extent to which a justice-relevant conclusion changes when the same

distributional process is represented at different justified scales, units, or internal decompositions.

Research on distributional justice should report such sensitivity when aggregation choices materially affect the conclusion. This makes scale selection part of the evidential record rather than an invisible preprocessing decision.

22.12.2 Relational Justice

Relational-justice research studies the terms on which economically consequential relations organize recognition, participation, reciprocity, dependence, authority, contestability, continuity, exit, and practical agency. Chapter 16's analysis of relational justice supplied the substantive normative architecture; the present task is to identify observable and reconstructable features through which those dimensions can be investigated. The unit of analysis can be a dyadic relation, an organizational arrangement, a network position, an institutional role, a contractual relation, a care relation, or a higher-order configuration when justice-relevant effects arise through relations among relations.

Research should distinguish formal from effective relational properties. A contract can provide exit while switching costs make exit practically unavailable. A governance process can provide voice while agenda control prevents consequential influence. Reciprocity can be formally symmetrical while one position supplies unrecorded maintenance work. Legal equality can coexist with dependence generated by housing, credit, platform access, credential recognition, or care. These are empirical questions about how the relation functions as well as normative questions about how its terms should be judged.

Definition 22.601 (Relational-justice research profile). *A relational-justice research profile* records the economically consequential relation, participating and affected positions, formation history, purpose, recognition structure, participation and authority, reciprocal claims, dependence, power, contestability, continuity conditions, effective exit, variation procedures, dissolution consequences, and the normative principles applied to those features.

The profile invites mixed-method research. Contracts and formal rules can establish declared terms; administrative records can show access and incidence; network analysis can reveal position and brokerage; interviews and ethnography can identify experienced dependence, recognition, or hidden maintenance burdens; process tracing can reconstruct how contestation alters decisions; and longitudinal evidence can show whether a relation becomes more or less dependent over time.

Proposition 22.602 (Formal-effective relational distinction). *A relational-justice claim that depends on participation, exit, contestability, reciprocity, or recognition should distinguish formal provision of that relation from its practical accessibility and consequential effect for the affected positions.*

Power research from Section 22.11 is especially relevant because non-domination and contestability depend on practical conditioning capacity. Yet evidence of power does not settle relational justice. Some authority, dependence, and durable commitment can be justified within care, public infrastructure, fiduciary relations, professional institutions, or collectively governed projects. The justice inquiry must therefore add purpose, legitimacy, safeguards, alternatives, burden incidence, and the normative standing of affected positions.

Definition 22.603 (Relational contestability test). A *relational contestability test* examines whether an affected position can obtain reasons, challenge consequential terms or classifications, access review, organize countervailing representation, or reach a practicable alternative within the horizon in which the contested relation produces material effects.

The test is intentionally practical. A nominal grievance channel with prohibitive delay or no capacity to alter the contested condition provides different evidence from a process that can suspend, revise, compensate, or overturn consequential decisions.

22.12.3 Generative Opportunity

Research on generative opportunity studies how present economic arrangements affect the later capacity to generate additional capabilities, relations, knowledge, institutions, options, and forms of participation. It operationalizes one central part of the generative-justice architecture developed in Chapter 16's analysis of generative justice. The object differs from a count of current opportunities. A current opportunity can be valuable while contributing little to later capability, and a modest present intervention can generate durable opportunity through learning, infrastructure, network access, recognition, or institutional change.

The empirical problem is therefore longitudinal and mechanism-sensitive. Researchers should specify the initial condition, the generative pathway, the later capability or option, the delay between them, the dependencies required for realization, and the positions for whom the pathway remains reachable. Education, seed funding, public infrastructure, legal status, care, research access, professional networks, interoperable standards, and community institutions can each function as opportunity-generating conditions in some settings. Their generative effects should be demonstrated rather than inferred from intention.

Definition 22.604 (Generative-opportunity profile). A *generative-opportunity research profile* records a present resource, relation, capacity, institution, or access condition; the mechanism through which it can generate later practical possibilities; the affected positions; required complementary conditions; latency and horizon; realized and unrealized pathways; burdens and dependencies; and the distribution and governance of the resulting possibilities.

Proposition 22.605 (Opportunity-generation identification condition). A *claim of generative opportunity* should identify a plausible and evidentially supported mechanism connecting the present condition to later practical possibility, together with the complementary conditions and horizon required for that connection.

The proposition distinguishes generative opportunity from aspirational description. Longitudinal administrative data, sequence analysis, event histories, network trajectories, interviews, comparative institutional studies, natural experiments, and carefully designed simulations can help identify such mechanisms. Qualitative evidence can be particularly important where opportunity depends on recognition, confidence, trust, informal access, or relational learning that conventional datasets do not record well.

Justice research must also examine foreclosure. An arrangement can expand one dimension of opportunity while narrowing others through debt, specialization, exclusive standards, geographic immobility, ecological depletion, contractual lock-in, or dependence on one intermediary. Raw option counts can therefore be misleading.

Definition 22.606 (Generative-opportunity incidence). *Generative-opportunity incidence* is the distribution across affected positions and time of the creation, maintenance, narrowing, concentration, diversification, and foreclosure of practically reachable future-generating pathways associated with an economic arrangement.

Research should preserve the multidimensional character of this incidence. Greater option diversity, stronger capability, better reversibility, and greater independence can move differently. A justice claim should state which of these features matters under the normative framework being applied.

22.12.4 Historical Justice

Historical-justice research investigates how past economic events, institutions, relations, harms, advantages, constraints, and evidential traces remain connected to present justice claims. Chapter 16's analysis of historical justice established that historical incidence, responsibility, repair, restitution, and re-epistemization require separate analysis. The research programme therefore centers on continuity mechanisms rather than temporal proximity alone. A present disparity can have a long history without being fully explained by that history, while a distant event can remain highly consequential where institutions, property relations, ecological changes, inherited constraints, or cumulative advantage preserve its effects.

Definition 22.607 (Historical-justice research dossier). A *historical-justice research dossier* records the candidate historical event or process, affected and benefiting positions where identifiable, transmitted harms or advantages, continuity mechanisms, institutional and material pathways, changing classifications, evidential provenance, present incidence, responsibility claims, candidate remedies, and relevant uncertainties or alternative historical explanations.

Historical reconstruction should preserve provenance. Archival records, law, property documents, organizational files, oral histories, testimony, demographic records, environmental evidence, financial accounts, maps, and later scholarship have different evidential properties. Missingness can also be structured: positions with weaker institutional power can leave fewer durable records. The absence of documentation therefore requires interpretation of archival production and survival rather than automatic inference of absence of effect.

Proposition 22.608 (Historical-continuity identification condition). *A present justice claim grounded in a past economic event or arrangement should identify the mechanism through which the historically relevant effect, claim, institution, advantage, constraint, or harm remains connected to the present position under study.*

The proposition leaves room for multiple continuity mechanisms. Property succession, infrastructure, institutional rules, ecological degradation, debt, exclusion, accumulated capability, organizational inheritance, legal status, network position, and cultural or epistemic classification can each sustain historical effects under different conditions. The mechanism should be tested against discontinuities, intervening causes, migration, institutional reform, changing membership, and other processes that can weaken or redirect the historical pathway.

Re-epistemization makes historical justice a moving research field. New evidence, testimony, classifications, methods, or causal models can alter what present researchers can responsibly claim about earlier events. A revision can strengthen the existence of harm while leaving the culpability of earlier actors uncertain; it

can identify previously omitted affected positions; or it can reveal that a proposed remedy reaches different positions from those initially assumed.

Definition 22.609 (Historical-justice revision record). A *historical-justice revision record* documents how new evidence, changed classifications, revised causal reconstruction, or altered normative premises modify a prior historical-justice claim, including which components of the earlier claim remain supported.

Such records are important for cumulative inquiry because historical justice is especially vulnerable to apparent contradiction produced by changing archives, categories, and claimant definitions. Versioned reconstruction can distinguish genuine evidential reversal from refinement of scope.

22.12.5 Intergenerational Justice

Intergenerational-justice research studies how economic arrangements transmit capacities, constraints, infrastructures, ecological conditions, institutions, risks, obligations, knowledge, and practical possibilities across cohorts or generations. The relevant transmission can occur through families, communities, organizations, legal systems, public infrastructure, ecological systems, educational institutions, debt, fiscal arrangements, technological standards, and durable relational architectures. The research object therefore extends beyond bequests or public debt to the conditions through which later positions acquire or lose generative capacity.

Future positions create an evidential and representational difficulty because many affected persons cannot participate directly in present inquiry or governance. Research should therefore distinguish empirical projection, scenario construction, proxy representation, legal or institutional guardianship, and substantive normative claims made on behalf of future positions. Each has a different epistemic status. Long-horizon models can illuminate trajectories, yet their uncertainty generally widens with time and with endogenous institutional or technological change.

Definition 22.610 (Intergenerational-justice research profile). An *intergenerational-justice research profile* records the transmitted condition, originating and later positions where identifiable, transmission mechanism, expected persistence or decay, uncertainty, reversibility, maintenance requirements, distribution of present burdens, distribution of future benefits or harms, representation of future standing, and normative principles governing temporal incidence.

Proposition 22.611 (Intergenerational transmission). An *intergenerational-justice claim* should identify the mechanism through which a present action or inherited condition materially changes the feasible capacities, burdens, ecological conditions, institutions, or practical possibilities of later positions within the horizon relevant to the claim.

Research should also distinguish preservation from generativity. Preserving an inherited institution can sustain future capacity in one context and reproduce harmful lock-in in another. Generating new capacity can expand later possibilities while consuming ecological or social conditions required by other future pathways. Empirical studies should therefore examine what is transmitted, what is transformed, what requires maintenance, and which revision capacities later positions retain.

Definition 22.612 (Intergenerational revision capacity). *Intergenerational revision capacity* is the practically available capacity of later positions to maintain, alter, re-

pair, repurpose, or discontinue inherited economic arrangements and their associated constraints without disproportionate loss of essential capabilities or conditions.

This concept creates a researchable bridge between option preservation and institutional inheritance. Indicators can include legal revisability, fiscal flexibility, interoperability, ecological recoverability, technical maintainability, knowledge preservation, and the cost of institutional exit, while qualitative inquiry remains necessary to interpret what those indicators mean in a particular historical setting.

22.12.6 Conversion Justice

Conversion-justice research evaluates the terms under which one economically relevant resource, capacity, claim, status, or value form becomes another recognized or usable form. Section 22.6 established conversion interfaces, conditions, rates, losses, gains, failure, and conversion power as descriptive research objects. Justice research adds questions of standing, rule justification, burden incidence, recognition, alternatives, participation, historical formation, and the distribution of conversion gains and losses.

Examples include credential recognition, currency exchange, benefit eligibility, professional licensing, accessibility accommodation, data-to-credit scoring, cultural or community knowledge entering commercial markets, intellectual contribution entering ownership regimes, and unpaid activity entering formal accounting or compensation systems. In each case, a conversion rule can determine which forms become institutionally legible and which remain difficult to realize.

Definition 22.613 (Conversion-justice research profile). *A conversion-justice research profile records the source and target forms, affected positions, interface controller, admissibility rules, conversion terms, recognition conditions, direct and indirect costs, losses and gains, complementary requirements, effective alternatives, appeal or review, historical formation, and the normative principles used to evaluate the interface.*

The profile requires research on both outcomes and architecture. A favorable average conversion rate can coexist with exclusion of positions whose source forms do not satisfy the recognition rule. A uniform rule can impose unequal burdens where prerequisite resources differ. A loss can be technically unavoidable, institutionally chosen, or strategically imposed. These distinctions matter for normative assessment.

Proposition 22.614 (Conversion-loss attribution condition). *A justice claim concerning conversion loss should distinguish loss generated by the underlying incompatibility of the source and target forms from loss generated by institutional rules, interface control, bargaining conditions, avoidable friction, discrimination, or historically produced conversion disadvantage.*

Research should also investigate who participates in setting conversion terms. Expertise can justify specialized standard setting, yet affected positions can possess knowledge about burden, usability, and exclusion that technical designers do not observe. Participatory design, appeals data, rejection records, audit studies, counterfactual simulations, qualitative interviews, and comparative institutional analysis can jointly illuminate conversion justice.

Definition 22.615 (Conversion-justice contestability). *Conversion-justice contestability is the practical capacity of affected positions to obtain reasons for conversion de-*

cisions, challenge classifications or terms, seek review, propose alternative recognition rules, or reach another effective interface before the consequences of failed or adverse conversion become materially entrenched.

The definition links conversion justice to the power analysis of Section 22.11. Contestability can constrain conversion power, although its justice depends additionally on accessibility, procedural burden, standing, and substantive remedy.

22.12.7 Circulation Justice

Circulation-justice research studies the justice-relevant organization of pathways through which value, resources, claims, information, burdens, recognition, and returns move among economic positions. Section 22.7 developed descriptive research on circulation, intermediation, transfer incidence, capture, dissipation, recirculation, and regeneration. The present subsection asks how source relations, recipients, intermediaries, maintainers, affected third parties, communities, and future positions are represented in normative evaluation of those pathways.

The research problem is often one of hidden incidence. A payment can reach its formal recipient while intermediaries retain substantial fees; a digital contribution can circulate widely while recognition and control remain concentrated; a policy transfer can benefit one household while shifting care or administrative burdens to another member; an infrastructure investment can expand regional access while concentrating ecological burden locally. Circulation justice therefore requires tracing beyond the visible transaction when downstream or upstream effects are material.

Definition 22.616 (Circulation-justice research profile). *A circulation-justice research profile records the circulating object or condition, source and recipient positions, intermediaries, maintainers, route and timing, transformations along the pathway, fees or capture, burdens and risks, participation in pathway governance, contestability, return or regeneration, downstream incidence, and normative principles relevant to the circulation process.*

Proposition 22.617 (Circulation-incidence extension). *Where a circulation pathway materially redistributes burdens, risks, recognition, control, maintenance obligations, or future options beyond its formal source and recipient, justice research should include those affected positions in the incidence analysis.*

Methods can include transaction tracing, supply-chain analysis, network and hypergraph representation, accounting, lifecycle analysis, institutional mapping, ethnography, beneficiary and affected-party studies, and historical reconstruction. Different methods observe different parts of the pathway. Research designs should therefore record known observability gaps, especially where informal labor, ecological burden, unpaid maintenance, or excluded intermediaries remain weakly documented.

Circulation justice also concerns pathway governance. An arrangement can distribute benefits broadly while concentrating authority over routing, timing, standards, or return. Another arrangement can be procedurally participatory while dissipating the value required to maintain the underlying relation. Outcome, process, and regenerative continuity should therefore remain separable in the research record.

Definition 22.618 (Circulation-governance incidence). *Circulation-governance inci-*

dence records how authority over routing, priority, standards, intermediation, retention, blockage, return, and revision of a circulation process is distributed across the positions that generate, maintain, receive, or are materially affected by that process.

22.12.8 Justice under Incommensurable Values

Justice research becomes especially demanding where materially relevant value forms lack a justified common metric. Section 22.5 treated incommensurability as a research question rather than a universal property of heterogeneous value. The justice programme should preserve the same restraint. Some value forms can be locally compared through prices, thresholds, legal standards, capability measures, negotiated equivalences, or domain-specific indicators. Others can resist justified aggregation because the relevant loss, right, relation, ecological condition, identity-bearing practice, or future possibility is altered by the conversion itself or because no accepted comparison rule exists.

The absence of a common metric does not end research. It changes the form of evidence and judgment. Researchers can identify value types, affected positions, threshold claims, rights constraints, priority rules, feasible alternatives, procedural legitimacy, uncompensated losses, and areas of persistent disagreement. Deliberative and participatory methods can reveal which conversions participants regard as unacceptable or incomplete, while historical and institutional analysis can show how apparently common metrics were produced and whose values they render legible.

Definition 22.619 (Incommensurable-value justice profile). An *incommensurable-value justice profile* records the materially relevant value forms, the evidence supporting their distinction, available local comparison rules, failed or contested conversions, thresholds or rights constraints, affected positions, procedures of judgment, residual losses, unresolved disagreement, and the conditions under which a common metric is considered unwarranted.

Proposition 22.620 (Metric non-requirement condition). *A justice inquiry does not require a common scalar measure where the relevant values can be responsibly compared through justified partial orderings, thresholds, domain-specific criteria, procedural rules, or explicitly unresolved plural judgments.*

Proposition 22.620 protects the research programme from manufacturing commensurability for analytical convenience. It also places a burden on claims of incommensurability. Researchers should test whether local comparison is possible before concluding that values cannot be compared, and they should specify the domain and decision for which commensurability fails.

Definition 22.621 (Residual-value loss). A *residual-value loss* is a justice-relevant loss that remains outside the principal comparison or compensation metric used in an economic decision and therefore requires separate representation if it materially affects the evaluation.

Residual-value analysis can make visible losses that a chosen metric systematically omits without assuming that every omitted value is overriding. The normative-premise register should record how such losses enter the judgment and whether compensation, prohibition, mitigation, participation, repair, or acknowledged remainder is the relevant response under the applied theory.

22.12.9 Justice under Heterogeneous Subjects

Justice research in generative economies must accommodate subjects and affected positions with heterogeneous capacities, needs, temporal standing, communicative forms, institutional status, and modes of participation. Economic arrangements can affect adults with different capabilities, children, persons whose decision-making or communicative capacities vary, future persons, collective bodies, communities, and nonhuman conditions or systems that enter economic evaluation through human institutions and normative theories. GRE does not require these positions to possess identical agency or to contribute symmetrically before they become justice-relevant.

The research challenge is to avoid using one model of participation as the proxy for standing. Survey response, market choice, contractual consent, electoral participation, verbal testimony, organizational membership, and productive contribution each reveal only some forms of interest or agency. Depending on the case, researchers may need supported decision-making, proxy or representative institutions, caregiver evidence, observational data, accessibility adaptation, historical testimony, ecological indicators, or institutionalized representation of future interests. These methods carry their own risks of substitution and misrepresentation.

Definition 22.622 (Heterogeneous-subject justice profile). A *heterogeneous-subject justice profile* records the affected positions, relevant forms of standing, capabilities and constraints on participation, needs for accommodation or support, available modes of expression or representation, risks of proxy distortion, contribution where relevant, dependence, exposure to burden, temporal position, and the normative principles governing inclusion in judgment.

Proposition 22.623 (Standing–contribution separation). *A subject's or affected position's justice-relevant standing should not be inferred solely from measurable productive or generative contribution; where contribution is normatively relevant, it should be recorded as one component of the evaluation rather than as the general criterion for inclusion.*

This proposition is important for empirical design because contribution-based datasets can systematically underrepresent positions whose economic significance appears through care, maintenance, dependency, future exposure, ecological support, or unrecorded relational work. Research should therefore distinguish absence of recorded contribution from absence of justice-relevant standing.

Definition 22.624 (Representation adequacy profile). A *representation adequacy profile* records who represents an affected position, the basis and scope of that representation, information available to the representative, conflicts of interest, opportunities for correction or contestation, uncertainty about preferences or interests, and the consequences of representational error.

Representation adequacy becomes especially important where direct participation is limited or impossible. The profile does not resolve which representative arrangement is morally preferable; it supplies the empirical and institutional record required for that normative judgment.

22.12.10 Transfer Justice

Transfer-justice research studies the justice of discrete or staged movements of resources, value, rights, obligations, access, claims, or support among specified posi-

tions. It builds on the transfer-incidence and transmission-justice programme of Section 22.7 and the justice-of-return programme of Section 22.8. The distinctive research object is the transfer event or transfer sequence together with the conditions that determine who actually bears costs, who receives benefits, which intermediaries shape the process, and how the transfer changes later dependence, capability, relation, or opportunity.

A formal sender–recipient description can be too narrow. Taxes can finance services through several layers of administration; remittances can redistribute household bargaining and care burdens; aid can pass through implementing organizations and procurement systems; platform payments can be reduced by fees and conversion costs; compensation can alter claims without repairing a damaged relation; and a transfer designed for one recipient can affect creditors, landlords, caregivers, local prices, or community institutions. Research should therefore distinguish legal destination, economic incidence, relational incidence, and generative incidence.

Definition 22.625 (Transfer-justice research profile). *A transfer-justice research profile* records the transferred object, formal sender and recipient, generators or contributors where relevant, intermediaries, affected third parties, eligibility and conditions, timing, conversion steps, direct and indirect incidence, administrative and participation burdens, dependency effects, return or recirculation, future-option effects, practical alternatives, and the normative principles used to evaluate the transfer.

Definition 22.626 (Transfer-incidence layers). *Transfer-incidence layers* distinguish at least the formal incidence of the declared transfer, the economic incidence of realized gains and costs, the relational incidence of changes in dependence or authority, and the generative incidence of changes in later capability or practical possibility when those layers are material to the inquiry.

Definitions 22.625 and 22.626 prevent a transfer from being evaluated solely through nominal amount. They also make explicit why the same transfer can have different justice profiles across institutional settings. A cash amount delivered quickly with low administrative burden, reliable portability, and little intermediary capture differs from the same nominal amount delivered after delay, costly documentation, compulsory conversion, or conditions that create long-lived dependence.

Proposition 22.627 (Nominal-transfer non-equivalence). *Equality or adequacy of nominal transfer amounts does not by itself establish equality or adequacy of transfer incidence where conversion conditions, timing, intermediation, administrative burdens, relational effects, or later generative consequences differ materially across affected positions.*

Comparative transfer research should therefore use feasible alternatives rather than an unspecified ideal whenever policy or institutional choice is the object. Alternatives can differ in universality, targeting, conditionality, delivery infrastructure, timing, portability, governance, and administrative cost. Causal designs can estimate selected outcomes, while process tracing and qualitative work can reveal burdens and relational changes omitted from outcome measures.

Definition 22.628 (Transfer revision condition). *A transfer revision condition* is an evidential or normative finding that materially weakens the justification for the current transfer architecture, such as misidentified incidence, systematic exclusion, excessive administrative burden, avoidable conversion loss, concentrated intermediary capture, harmful dependence, failure of intended generative effects, or a superior feasible alternative under the stated normative premises.

Transfer revision conditions make the section's broader programme discipline operational. Justice research should be able to alter institutional design when empirical incidence differs from assumed incidence or when normative premises are shown to have been applied inconsistently. The same principle applies across the entire section: a justice framework becomes researchable when its descriptive dependencies can be investigated, its normative premises can be stated, disagreements can be localized, and evidence can revise the claims built upon them.

Taken together, the ten domains treat justice in generative economies as a multi-dimensional and historically extended research object. Distribution, relation, generation, conversion, circulation, history, temporal inheritance, subject heterogeneity, and transfer can interact within one case while retaining distinct evidential burdens. The resulting programme therefore favors structured profiles and explicit normative premises over premature scalar synthesis. Section 511 applies the same discipline to a more specific and demanding concept: generative exploitation, where extraction, capture, dependency, asymmetric return, and foreclosure must be identified with sufficient precision to distinguish them from inequality or disadvantage alone.

22.13 Research on Generative Exploitation

The role of this section is to convert the book's earlier analysis of extraction, capture, dependency, generative depletion, power, return, and epistemic exploitation into a general empirical research programme for *generative exploitation*. Chapter 14 distinguished dissipation, leakage, extraction, dependency, and generative depletion; Chapter 16 separated asymmetry from power and power from injustice; Chapter 17 developed the more specific case of generative exploitation in epistemic systems. Sections 22.6–22.12 have in turn specified research programmes for conversion, circulation, generative return, spacetime, fast–slow dynamics, power, and justice. The objective here is to establish how a claim of generative exploitation can be identified, compared, tested, weakened, or rejected across economic domains without turning any unequal exchange, appropriation, unpaid contribution, dependency, or unfavorable outcome into exploitation by definition. The discussion proceeds through extraction, value capture, knowledge capture, relational capture, dependency, option foreclosure, asymmetric return, self-reinforcing exploitation, and empirical identification. The method is relational, process-oriented, historical, and mechanism-sensitive. It combines provenance reconstruction, incidence analysis, longitudinal observation, counterfactual reasoning, institutional analysis, process tracing, interviews, ethnography, archival research, network and transaction data, comparative cases, and formal models where those methods fit the object.

The research problem is difficult because several weaker observations can resemble exploitation while remaining analytically insufficient. One position can earn more than another because it contributed a scarce input, assumed greater risk, possessed a complementary capability, or entered the process under a different institutional role. A platform can retain a commission that finances infrastructure. A research institution can aggregate shared knowledge while returning access and maintenance resources to contributors. A worker can depend on an employer while possessing credible alternatives and gaining transferable capability. Conversely, apparently voluntary and compensated arrangements can become exploitative when bargaining asymmetry, control over conversion, loss of portability, or repeated

source-side depletion progressively narrows practical alternatives. A research programme therefore needs to reconstruct a *generative relation through time* rather than classify a transaction from a single distributive snapshot.

Section 413 of Chapter 17 defined generative exploitation in epistemic systems as asymmetrical appropriation or control through which one position expands capacity using another position's contributions or generative conditions while the source side experiences materially relevant weakening of control, return, alternatives, maintenance, or future generativity connected to that process. The present section retains that diagnostic discipline and generalizes its research architecture across economic domains. It does not propose a replacement definition of exploitation. Instead, it specifies the evidential objects required to investigate whether the previously defined mechanism is present in a particular case.

Definition 22.629 (Exploitation research profile). A *generative-exploitation research profile* records, for a specified relation and historical horizon, the source position, materially relevant contribution or generative condition, beneficiary or controlling position, appropriation or control interface, enabling asymmetry, conversion and realization pathway, forms of captured value or capability, return structure, governance and contestability, source-side changes in control, maintenance, alternatives, and future generative capacity, relevant comparison or counterfactual, competing explanations, evidential uncertainty, and conditions under which the exploitation claim should be weakened or rejected.

The profile has three analytical layers. The first reconstructs *provenance*: what was contributed, by whom or by which shared configuration, under what institutional and historical conditions, and how materially the contribution entered later generation. The second reconstructs *appropriation and realization*: which position obtained value, capability, control, or durable advantage, through which interface, and with what dependence on the source contribution. The third reconstructs *generative consequence*: whether the source side's capacity to maintain, reproduce, redirect, govern, or continue generating was materially weakened in a way connected to the appropriation process. Evidence can be strong at one layer and weak at another. Research should preserve those differences rather than average them into an overall label.

Proposition 22.630 (Generative-exploitation identification condition). A *finding of unequal benefit, capture, dependency, non-payment, bargaining asymmetry, or source-side loss does not by itself establish generative exploitation. A stronger identification requires evidence connecting a materially relevant source contribution or generative condition to an asymmetrical appropriation or control mechanism and connecting that mechanism to materially relevant weakening of the source side's control, return, practical alternatives, maintenance conditions, or future generative capacity within the stated horizon.*

Proposition 22.630 makes counterevidence constitutive of the programme. If contributors retain strong control, obtain returns material to reproduction, can exit or redirect their contributions at reasonable cost, develop transferable capability, or experience improved future options, the stronger exploitation diagnosis may fail even where benefits remain unequal. If an apparent source-side decline is caused principally by technological obsolescence, ecological shock, independent policy change, internal governance failure, or another process not connected to the alleged appropriation, causal attribution should likewise weaken. Conversely, formal consent, contract, or payment cannot by itself defeat an exploitation claim where the empirical

Table 22.13: Principal research domains in generative exploitation

Domain	Primary object	Evidence	Boundary
Extraction	Appropriation or control of value-bearing contributions under asymmetry	Provenance, appropriation interface, source-side consequence, alternatives	Loss, profit, or transfer is not automatically extraction
Value capture	Retention or control of realized value and downstream returns	Contribution, mediation, conversion, retention, governance, incidence	Capture is not automatically exploitative or unjust
Knowledge capture	Appropriation of knowledge, data, methods, interpretation, or epistemic capability	Provenance, access rights, attribution, downstream control, reuse and return	Knowledge use or diffusion is not automatically capture
Relational capture	Appropriation of trust, care, legitimacy, access, coordination, or network value	Maintenance burden, reciprocity, exit, gatekeeping, relational depletion	Relational benefit is not automatically extraction
Dependency	Contingency of later action on another position or infrastructure	Replaceability, switching burden, timing, complementarities, governance	Dependence is not automatically exploitation
Option foreclosure	Material narrowing of reachable future actions or trajectories	Prior reachability, mechanism of closure, substitute options, irreversibility	Non-selection is not foreclosure
Asymmetric return	Unequal or mismatched return to generative sources	Return form, timing, recipient, adequacy for reproduction, governance	Unequal return is not sufficient for exploitation
Self-reinforcement	Recursive reproduction of the exploitation-enabling configuration	Feedback, cumulative advantage, lock-in, learning, institutional reproduction	Persistence is not by itself self-reinforcing exploitation

record shows that the arrangement operates through severe constraint, opaque appropriation, non-portable dependence, or cumulative depletion.

Table 22.13 summarizes the principal research domains developed below. The rows are not mutually exclusive. A single arrangement can combine value capture, knowledge capture, relational capture, dependency, option foreclosure, and asymmetric return, and the interaction among these mechanisms can be more important than any component considered alone.

22.13.1 Extraction

Research on extraction should begin from the process distinction established in Section 361 of Chapter 14. Extraction concerns asymmetrical realization, appropriation, or control of value generated with material contribution from another position or shared generative configuration together with materially relevant source-side loss of control, return, option, maintenance capacity, or future generative capacity. The empirical task is therefore not to search for a single “extraction variable.” It is to reconstruct a typed relation among contribution, appropriation, asymmetry, realization, and consequence.

The first requirement is contribution provenance. Researchers should identify which resources, capabilities, relations, infrastructures, ecological conditions, knowledge stocks, care activities, legitimacy, attention, or other generative conditions entered the process and how their material relevance can be established. Provenance can be direct, as where a supplier provides a component incorporated into a product, or distributed, as where a community, ecosystem, open repository, or institutional tradition supplies conditions without which later realization would have been substantially different. Distributed provenance requires restraint because almost every economic process depends on broad social conditions. The research claim should

specify why the selected source is material to the mechanism rather than merely part of an indefinitely extended causal background.

The second requirement is the appropriation interface. Contract, ownership, platform rule, licensing regime, purchasing arrangement, debt relation, employment hierarchy, algorithmic allocation, data pipeline, procurement rule, land tenure, intellectual-property regime, or informal gatekeeping relation can each organize appropriation differently. Researchers should ask which rights and practical capacities govern use, exclusion, modification, resale, downstream conversion, transfer, termination, and return. A legal right can be relevant without exhausting effective control, particularly where enforcement, information, bargaining resources, or exit capacity differ markedly among positions.

Definition 22.631 (Extraction trace). An *extraction trace* is an empirically supported sequence linking a specified source contribution or generative condition to an appropriation or control interface, a realization or conversion pathway, an identifiable beneficiary or controlling position, and a materially relevant source-side change in control, return, options, maintenance, or future generative capacity.

An extraction trace can be assembled through contracts, transaction records, production data, ownership records, platform rules, licensing terms, interviews, process observation, supply-chain evidence, organizational archives, and longitudinal outcome data. Different evidence supports different links. A contract can document formal rights but not practical bargaining. Financial records can show realized revenue but not provenance of relational or ecological contribution. Interviews can reveal dependence or maintenance burdens but require triangulation where causal attribution is contested.

Proposition 22.632 (Extraction-trace completeness condition). *Where one or more indispensable links between contribution, appropriation, realization, and source-side consequence remain empirically unsupported, the research record should identify the extraction claim as partial or uncertain rather than infer the missing mechanism from unequal outcomes alone.*

The proposition does not demand impossible causal completeness. Historical research often proceeds under incomplete records, and distributed production can make exact attribution difficult. It instead requires explicit localization of uncertainty. This practice is especially important in politically or morally charged cases, where the vocabulary of extraction can otherwise substitute for mechanism-level evidence.

22.13.2 Value Capture

Value capture is a broader object than generative exploitation. Section 357 of Chapter 14 defined capture relative to value-bearing flows and distinguished it from contribution and necessary mediation. A tax authority captures part of an income flow, a platform retains a commission, a patent holder receives licensing revenue, a cooperative retains surplus for common investment, and an intermediary receives a fee. Such arrangements can be legitimate, productive, contested, inefficient, or exploitative depending on their mechanisms and institutional context. Research on generative exploitation therefore needs a way to study capture without presuming its normative meaning.

A value-capture study should identify the relevant value form before measuring

the captured share. Financial retention is often easiest to observe, but economic processes can also capture capability, reputation, data, control rights, bargaining advantage, market access, attention, organizational learning, or future option value. These forms can interact. A firm can accept a low present margin in exchange for exclusive data access that improves later capability. A worker can receive high monetary compensation while losing portability of knowledge or future occupational alternatives. A community can receive financial payments while losing authority over an ecological or cultural resource. Research should therefore avoid treating the monetary share as a sufficient representation of total capture.

Definition 22.633 (Value-capture profile). A *value-capture profile* records the value forms generated, positions contributing to generation and maintenance, positions realizing or controlling downstream value, mediation functions, retained shares or rights, conversion pathways, temporal distribution of returns, governance of retention, and source-side consequences relevant to continued generation.

The profile permits comparison among cases with different institutional forms. One useful distinction is between *functional retention* and *appropriative retention*. Functional retention finances maintenance, risk bearing, infrastructure, coordination, verification, reserves, or another demonstrated contribution to continued operation. Appropriative retention refers descriptively to captured value whose relation to contribution or necessary mediation is weak or contested. This distinction remains empirical before it becomes normative: high functional costs can be inefficient, and appropriative retention can be legally authorized. The research task is to identify what the retained value does within the system and how the retention arrangement affects other positions.

Proposition 22.634 (Capture–exploitation non-equivalence). *Value capture supports a generative-exploitation claim only where the capture is linked to an asymmetrical appropriation or control mechanism and to materially relevant weakening of the source configuration’s control, return, alternatives, maintenance, or future generative capacity.*

Longitudinal evidence is particularly important. A high captured share in one period can finance infrastructure that later expands contributors’ capabilities; a small recurring capture can cumulatively produce lock-in and source depletion. Researchers should therefore examine reinvestment, return, portability, bargaining evolution, and changes in source generativity rather than classify arrangements from a one-period division of surplus.

22.13.3 Knowledge Capture

Knowledge capture extends the general research architecture into cases where knowledge, data, methods, interpretation, tacit competence, cultural knowledge, training material, feedback, standards, or other epistemic contributions are incorporated into assets or capabilities controlled elsewhere. Chapter 17 examined this problem within epistemic systems. The present subsection treats knowledge capture as one mechanism that can appear across firms, public institutions, platforms, research organizations, supply chains, communities, professional systems, and AI-mediated production.

The primary empirical difficulty is that knowledge can often be copied or recombined without physical removal from the source. Source-side loss can therefore arise through changed control, attribution, bargaining, access, recognition, portability,

downstream exclusion, or substitution pressure rather than literal dispossession of the informational object. Research should reconstruct both the epistemic contribution and the institutional architecture that governs later use.

Definition 22.635 (Knowledge-capture research profile). A *knowledge-capture research profile* records the epistemic contribution and its provenance, mode of elicitation or acquisition, consent or participation conditions where relevant, codification and aggregation process, rights of access and reuse, attribution, downstream conversion into economic or institutional capability, control over resulting assets, return to source positions, portability, contestability, and changes in the source side's later epistemic or economic capacity.

Research can combine document histories, version control, contribution records, licensing terms, data provenance, model or product documentation, interviews, ethnography, publication and patent data, organizational process tracing, and downstream revenue or capability analysis. The appropriate unit may be an individual contributor, team, community, occupational group, open-source project, repository, or historically accumulated knowledge system. Attribution should match that unit. Excessively individualized provenance can erase collective generation, while excessively collective attribution can obscure identifiable contributors and governance rights.

Knowledge capture should also be distinguished from knowledge diffusion. Broad reuse can expand the source's influence, create reciprocal learning, enlarge a commons, or generate reputational and capability returns. Restrictive control can likewise coexist with substantial source benefit. The exploitation question concerns whether appropriation and control are connected to a deterioration in the source's generative conditions, not whether downstream actors learn or profit.

Proposition 22.636 (Knowledge-capture consequence condition). *Where downstream use of an epistemic contribution leaves source positions with sustained or improved access, attribution, control appropriate to the arrangement, practical alternatives, maintenance resources, and future capability, knowledge capture alone provides insufficient evidence for generative exploitation.*

The proposition is especially important for research on open science, public data, education, standardization, and commons. These institutions often aim at reuse. Their vulnerability to generative exploitation lies not in openness itself but in arrangements through which stronger conversion capacity can privatize downstream capability, externalize maintenance burdens, or weaken the continuing conditions of shared generation.

22.13.4 Relational Capture

Relational capture concerns economic realization that depends materially on trust, care, legitimacy, reputation, community access, coordination, brokerage, network participation, emotional labor, or another relational condition while the arrangement concentrates control or return and weakens the capacity to maintain or redirect the relation. Chapter 14 treated relational extraction as a distinct process because the appropriated condition is often inseparable from ongoing interaction. Research on generative exploitation should therefore treat maintenance of the relation as part of production rather than as an invisible background.

Empirical designs should identify who performs relational maintenance, which ac-

tors depend on it, what costs or risks it carries, how it is recognized, and who can alter the rules governing the relation. In care work, maintenance can involve time, emotional availability, coordination, and bodily effort. In communities, it can involve legitimacy, translation, trust, mediation, and conflict resolution. In platforms, value can depend on users creating network density, reputational signals, moderation, reviews, and interaction histories. In supply chains, long-standing cooperation can embed adaptation and tacit coordination that are costly to rebuild elsewhere.

Definition 22.637 (Relational-maintenance incidence). *Relational-maintenance incidence* records which positions perform the work or bear the costs required to reproduce an economically relevant relation, which positions realize benefits from that relation, how authority over continuation and modification is distributed, and how maintenance burdens and returns change over time.

Relational-maintenance incidence can be investigated through time-use data, workload records, interaction logs, network analysis, interviews, ethnography, contract histories, turnover, dispute records, and measures of trust or coordination where those measures are substantively valid. Quantification should not erase the qualitative content of a relation. A count of interactions, for example, cannot establish whether participants experience reciprocity, coercion, care, obligation, or strategic compliance.

Definition 22.638 (Relational-capture mechanism). A *relational-capture mechanism* is a process through which one position realizes value from an economically relevant relation while controlling or externalizing a materially important share of the conditions required for the source side to maintain, exit, repair, redirect, or build alternatives to that relation.

This definition directs research toward gatekeeping and exit. A relation can be asymmetric yet non-exploitative where both sides retain meaningful alternatives, maintenance burdens are sustainable, governance is contestable, and repeated participation strengthens capability. Conversely, a seemingly cooperative relation can become exploitative where accumulated trust or dependence is used to impose terms that deplete the source side's relational capacity.

Proposition 22.639 (Relational-maintenance test). *Evidence that a value-realizing relation reproduces the source side's maintenance capacity, practical exit, reciprocal access, and ability to form alternative relations should weaken a generative-exploitation claim based principally on relational capture.*

The test is deliberately dynamic. Relational exploitation often appears through cumulative exhaustion rather than immediate transfer. Longitudinal research on burnout, turnover, trust erosion, network narrowing, community withdrawal, or increasing switching burdens can therefore reveal mechanisms invisible in transaction-level data.

22.13.5 Dependency

Dependency is a central mechanism in generative exploitation research because appropriation can become durable when the source position cannot readily replace the relation, infrastructure, market, capability, creditor, platform, employer, buyer, supplier, or knowledge system through which participation occurs. Yet dependency is not itself exploitation. Economic organization routinely relies on specialization, interdependence, durable commitment, care, infrastructure, and coordinated expectations.

Research must distinguish productive or mutually governed dependence from dependence that is converted into appropriation and source-side generative weakening.

The relevant object is *practical dependency*. Nominal alternatives can coexist with high switching costs, long replacement times, legal restrictions, lost reputation, non-portable data, incompatible standards, geographic constraints, debt obligations, relational loss, or missing complementary capabilities. Researchers should therefore measure alternatives in terms of reachability within the relevant time horizon rather than simple market counts.

Definition 22.640 (Generative-dependency profile). A *generative-dependency profile* records the capability, relation, infrastructure, resource, or interface on which a source position's continued generation depends; the controlling or supplying position; available substitutes; switching burdens; replacement time; complementary requirements; contractual and institutional constraints; governance rights; exposure to unilateral change; and consequences for future generation if access is withdrawn or terms deteriorate.

The profile can be applied at multiple scales. A worker can depend on an employer for income, credential accumulation, equipment, or immigration status. A small supplier can depend on one buyer for market access. A research community can depend on a database, publisher, cloud provider, instrument, or funding architecture. A state can depend on imported technology, financing, energy, or payment infrastructure. A community can depend on an external organization for services after local capacity has weakened. The same method should not be imposed across these domains, but the relational questions remain comparable.

Proposition 22.641 (Dependency conversion condition). *Dependency becomes evidence within a generative-exploitation claim only where an identifiable mechanism converts the dependency into appropriation, control, adverse terms, constrained exit, externalized maintenance burden, or another process connected to source-side generative weakening.*

Research should also study dependency creation. Some arrangements inherit dependence from earlier history; others actively deepen it through exclusivity, interoperability restrictions, debt structures, loss-leading pricing, proprietary standards, tied services, non-portable reputation, removal of local alternatives, or cumulative specialization. Establishing that a position benefits from pre-existing dependence is analytically different from showing that it created or strategically intensified the dependence.

A useful source of counterevidence is dependency dilution. Training, interoperability, diversification, collective organization, public infrastructure, open standards, portability, savings, alternative financing, or learning can increase the source position's practical alternatives. If dependence declines while returns and capacity increase, a hypothesized self-reinforcing exploitation mechanism may be unsupported even where asymmetry persists.

22.13.6 Option Foreclosure

Option foreclosure connects exploitation research to the book's analysis of future possibility. Section 362 of Chapter 14 distinguished foreclosure from ordinary non-selection: an option is foreclosed when a previously reachable or plausibly preservable future action, relation, institutional arrangement, or trajectory becomes unavail-

able or practically inaccessible because of a specified process. Generative exploitation research asks whether appropriation or control contributes to such narrowing and whether the narrowing increases the durability of the exploitative relation.

The first empirical task is to identify the prior option set responsibly. Counterfactual options should not be invented merely because they are imaginable. Evidence can come from previous practices, comparable positions, institutional rules, feasible technical alternatives, observed switching by similar actors, historical trajectories, or credible plans that were later rendered inaccessible. The second task is to identify the closure mechanism. Financial depletion, loss of transferable skills, contractual restriction, data non-portability, ecological damage, reputational dependence, institutional exclusion, infrastructure lock-in, or destruction of alternative relations can each reduce practical reachability.

Definition 22.642 (Option-foreclosure trace). An *option-foreclosure trace* links a previously reachable or credibly preservable future option to a specified appropriation, control, or dependency mechanism and documents how that mechanism removes the option or raises the resources, time, risk, coordination, or institutional requirements for access beyond a materially relevant threshold.

The threshold is context-dependent. A delayed option can remain meaningful in one setting and become effectively unavailable in another. For a household facing immediate housing loss, a six-month procedural remedy may be practically irrelevant. For an industrial technology transition, several years can remain a meaningful horizon. Research should state the temporal scale and the basis for treating an option as practically accessible or foreclosed.

Proposition 22.643 (Foreclosure reinforcement condition). *Where appropriation or control generated in one period materially forecloses alternatives that would otherwise discipline the relation in later periods, option foreclosure can operate as a reinforcing mechanism of generative exploitation.*

The proposition creates a bridge between local process tracing and dynamic analysis. An arrangement can begin under meaningful choice and become increasingly difficult to leave. Conversely, policies that restore portability, rebuild local capacity, lower switching costs, or create interoperable alternatives can reopen options without eliminating the original relation. Empirical research should therefore examine trajectories of reachability rather than infer freedom or constraint solely from the conditions present at entry.

22.13.7 Asymmetric Return

Generative return research in Section 22.8 asked whether value or capacity returns to the relations, communities, knowledge systems, capabilities, and future options that materially contributed to generation. Generative exploitation research asks a narrower question: whether the return structure, in combination with appropriation and asymmetry, contributes to the weakening of those source conditions. Unequal return is therefore relevant but insufficient. Different positions can justifiably receive different returns because contributions, risks, needs, roles, institutional purposes, or agreed rules differ.

Research should distinguish the *amount, form, timing, recipient, and generative adequacy* of return. Monetary payment can be substantial while failing to restore access, knowledge, ecological conditions, relational capacity, or governance rights ma-

terial to continued generation. Non-monetary return can sometimes be more important than payment, as with attribution, training, infrastructure, data access, shared control, maintenance support, or rights to reuse. Delayed return can be appropriate where value takes time to realize, but delay can also shift risk toward source positions that lack the resources to sustain generation during the waiting period.

Definition 22.644 (Generative-return adequacy). *Generative-return adequacy* is the empirically assessed relation between the forms, timing, control, and recipients of return and the resources, capabilities, relations, maintenance conditions, and practical options required for the materially contributing source configuration to continue or redirect generation over the stated horizon.

The definition does not create a universal entitlement rule. It creates a research object that normative theories can evaluate differently. A sufficientarian account, reciprocity account, rights-based theory, capability approach, contractual theory, or account of repair can assign different significance to the same return profile. Section 22.12 therefore remains the normative interface.

Proposition 22.645 (Asymmetric-return exploitation condition). *An asymmetric return structure strengthens a generative-exploitation claim when the asymmetry is produced or maintained through the relevant appropriation or control mechanism and when the resulting return is materially inadequate for reproduction, maintenance, practical alternatives, or future generative capacity of the source configuration.*

Empirical work can compare contract terms, revenue shares, reinvestment, maintenance expenditure, training, attribution, governance rights, benefit incidence, ecological restoration, community infrastructure, portability, and long-horizon capability. The appropriate denominator depends on the case. Comparing return only with immediate output value can obscure maintenance burdens; comparing it only with contribution estimates can obscure future option loss. Researchers should report several relevant baselines when no single comparison has sufficient warrant.

22.13.8 Self-Reinforcing Exploitation

Generative exploitation becomes especially consequential when the process reproduces or intensifies the conditions that permit continued appropriation. The relevant dynamics can involve cumulative capital advantage, weakened alternatives, institutional rule formation, network effects, knowledge asymmetry, debt, concentration, de-skilling, ecological depletion, reputational dependence, or differential learning. The research objective is to identify feedback rather than infer self-reinforcement from persistence alone.

A persistent exploitative arrangement can remain stable because external conditions change little, because enforcement prevents exit, because affected positions prefer it to worse alternatives, or because the process actively reproduces its own enabling asymmetry. Only the last class is self-reinforcing in the stronger dynamic sense developed here. Research should therefore identify the feedback channel and examine whether variation in the alleged output of one period predicts or causes changes in the enabling conditions of later periods.

Definition 22.646 (Exploitative feedback loop). *An exploitative feedback loop* is a recurrent process in which value, capability, control, or positional advantage realized through a generative-exploitation mechanism is converted into conditions that materially increase the later feasibility, reach, intensity, or persistence of that mechanism

while the source side's alternatives or generative conditions remain weakened.

Possible loops include captured revenue financing acquisition of competitors or exclusive infrastructure; knowledge capture improving predictive capability that strengthens gatekeeping; dependency reducing bargaining power and thereby worsening terms that deepen dependency; option foreclosure increasing switching costs; relational depletion reducing collective capacity to negotiate; or asymmetric return preventing source-side investment in alternatives. These are mechanism hypotheses, not consequences that should be assumed whenever concentration increases.

Proposition 22.647 (Self-reinforcement evidence condition). *A self-reinforcing generative-exploitation claim should identify a feedback pathway through which outputs or advantages generated by the alleged exploitation mechanism alter later conditions in ways that increase the mechanism's persistence or intensity, and it should distinguish that pathway from common external causes of both persistence and asymmetry.*

Longitudinal and comparative designs are especially valuable. Researchers can examine changes before and after interoperability requirements, collective bargaining, antitrust intervention, ownership reform, portability rules, debt restructuring, open-access mandates, public alternatives, or other institutional changes that plausibly interrupt the feedback channel. Agent-based, network, system-dynamics, or other formal models can help articulate possible feedback structures, but the model should remain subordinate to empirical identification of the relevant mechanism and parameter range.

Self-reinforcement can also fail. A dominant position can over-extract and destroy its own source conditions; contributors can learn and exit; new technologies can lower switching costs; institutions can create countervailing power; collective organization can redistribute governance; or captured knowledge can diffuse despite attempts at control. These failure modes are not anomalies to be excluded from the theory. They are part of the empirical programme because they identify the conditions under which exploitation is unstable, reversible, or self-limiting.

22.13.9 Empirical Identification

The preceding subsections imply that generative exploitation is best studied as a structured causal and historical claim rather than a single observable variable. Empirical identification should combine evidence about provenance, asymmetry, appropriation, conversion, capture, return, dependency, option change, and source-side generative consequences. No method can observe all of these dimensions equally well. The research design should therefore state which links are directly observed, which are inferred, which remain uncertain, and which rival mechanisms have been tested.

A practical study can begin with a candidate relation and construct the generative-exploitation research profile in Definition 22.629. The investigator then develops extraction traces, capture profiles, dependency profiles, option-foreclosure traces, and return evidence only where those modules are relevant to the case. This modular architecture avoids forcing every study to collect every conceivable variable while preserving comparability across cases.

Definition 22.648 (Exploitation evidence dossier). *A generative-exploitation evidential dossier is the case-specific body of evidence that supports or challenges the links among source contribution, appropriation or control, enabling asymmetry, realized*

value or capability, return, source-side consequence, temporal development, and alternative explanations. It records the evidential status of each link separately and preserves contradictory or negative findings.

Several empirical strategies can contribute. *Process tracing* can reconstruct appropriation and institutional change. *Longitudinal data* can examine whether source-side capacity, alternatives, or maintenance conditions decline as appropriation deepens. *Comparative cases* can test whether similar contributions under different governance structures produce different return and depletion patterns. *Natural or policy experiments*, where defensible, can examine changes following rules that alter bargaining, portability, access, ownership, or return. *Network and transaction analysis* can map capture and dependency pathways. *Interviews and ethnography* can reveal tacit maintenance burdens, practical exit constraints, and meanings that administrative data omit. *Archival and historical research* can reconstruct how apparently voluntary present arrangements were produced by earlier institutional changes. *Participatory inquiry* can identify source-side generative conditions that external researchers would otherwise misclassify.

Measurement should remain typed. Financial extraction can be represented through prices, margins, rents, fees, or revenue shares where those quantities match the mechanism. Capability depletion can require skill measures, learning trajectories, health or time indicators, access to complementary resources, or task substitution. Relational depletion can require turnover, network loss, trust evidence, maintenance burden, or qualitative reconstruction. Epistemic capture can require provenance, attribution, licensing, data access, downstream control, and knowledge portability. Option foreclosure can require feasible-alternative analysis. A composite index can be useful for a defined application, but it should not erase the mechanisms from which it is constructed.

Proposition 22.649 (Multi-link falsification condition). *A generative-exploitation hypothesis should be weakened when evidence fails at a mechanism-critical link, including materially relevant contribution, appropriation or control, enabling asymmetry, causal connection to source-side generative weakening, or the absence of a more plausible rival explanation. Evidence of inequality or harm at another link does not automatically repair the missing identification.*

The proposition gives the concept a practical falsification structure. A study can find severe inequality without exploitation, harmful dependency without appropriation, extraction without durable generative depletion, or generative depletion without an identifiable beneficiary. Those findings remain substantively important. They should be reported in their own terms rather than upgraded to generative exploitation for rhetorical force.

The programme also requires research on heterogeneity. The same arrangement can be exploitative for one source position and capacity-enhancing for another because prior resources, bargaining power, portability, social protection, geographic alternatives, or historical relations differ. Average effects can therefore conceal incidence. Distributional analysis should be combined with relation-specific and subgroup analysis where heterogeneity is material.

Temporal boundaries deserve similar attention. Short-run extraction can coexist with long-run capability formation, while initially favorable exchange can become exploitative after alternatives disappear. Researchers should justify the horizon over which generative consequences are assessed and, where possible, report results at

several horizons. Fast-slow analysis from Section 22.10 can be particularly useful when immediate outputs and slow institutional or capability changes diverge.

Finally, empirical identification should preserve the boundary between diagnosis and normative judgment. Generative exploitation is already a stronger relational diagnosis than simple inequality because it includes appropriation and source-side generative weakening. Yet questions concerning remedy, compensation, prohibition, redistribution, governance, consent, rights, desert, sufficiency, reciprocity, or repair require additional normative premises of the kind made explicit in Section 22.12. An empirically well-supported exploitation diagnosis can therefore constrain normative reasoning without determining a complete theory of justice.

Proposition 22.650 (Research-programme closure). *Within the GRE research programme, generative exploitation should be treated as a revisable mechanism-level hypothesis whose empirical adequacy depends on reconstructing contribution, appropriation or control, asymmetry, return, and source-side generative consequence across an explicit historical horizon, while preserving extraction, capture, dependency, option foreclosure, harm, power, and injustice as related but non-identical analytical categories.*

Proposition 22.650 completes the section's research architecture. It also establishes the transition to Section 512. Knowledge capture, epistemic dependency, and asymmetrical conversion are important possible components of generative exploitation, but the epistemic economy contains a much wider set of research problems concerning abundance, attention, question selection, aesthetic judgment, orientation, knowledge capital, unequal generative capacity, and AI-mediated knowledge production. The next section therefore turns from exploitation as a mechanism family to the broader empirical programme of epistemic economy.

22.14 Research on Epistemic Economy

The role of this section is to convert the epistemic-economy architecture developed in Chapter 17 into a research programme capable of identifying how knowledge-related abundance, scarcity, attention, question formation, judgment, orientation, accumulated epistemic capacity, and artificial-intelligence mediation alter economic possibility. The objective is to make these objects empirically tractable while preserving distinctions established earlier in the book: symbolic output from warranted knowledge, visibility from sustained attention, available answers from good question formation, aesthetic preference from epistemically consequential judgment, information possession from mobilizable knowledge capital, and local capability difference from persistent generative asymmetry. The discussion proceeds through knowledge abundance, attention scarcity, question selection, aesthetic judgment, epistemic orientation, knowledge capital, unequal generative capacity, and AI-mediated knowledge production. The method is plural and mechanism-centered. It combines longitudinal and comparative measurement, bibliometric and network analysis, process tracing, institutional and archival reconstruction, ethnography, interviews, experiments where appropriate, provenance analysis, computational audit, and qualitative reconstruction of inquiry trajectories.

The epistemic economy is unusually difficult to study because many of its consequential objects are partly endogenous to the institutions used to observe them. Pub-

lication systems help define what becomes countable as knowledge output. Search systems alter which records are encountered. Funding systems shape the questions later measured as research activity. Evaluation regimes influence which forms of judgment acquire institutional force. AI systems can both produce candidate epistemic material and become instruments through which that material is classified, summarized, ranked, or evaluated. Research design must therefore record the observation architecture itself rather than treat available traces as neutral samples of an independently given epistemic field.

Definition 22.651 (Epistemic-economy research profile). An *epistemic-economy research profile* is a structured record of the epistemic objects, producing and receiving positions, attention and verification capacities, question-selection mechanisms, judgment and orientation practices, accumulated epistemic resources, access and control relations, institutional and technical infrastructures, temporal horizons, distributional consequences, and evidential limitations relevant to a specified research claim about the economic organization of knowing.

The profile in Definition 22.651 is deliberately wider than a publication or information-production record. A research system can generate more papers while narrowing the distribution of questions, produce more data while weakening interpretation, enlarge access while concentrating verification capacity, or increase apparent productivity while shifting unrecorded burdens toward curation, checking, synthesis, and maintenance. The research programme must therefore follow the entire epistemic pathway from possible encounter and problem formation through generation, evaluation, accumulation, circulation, use, and preservation.

Proposition 22.652 (Epistemic-output inference condition). *A change in the volume, speed, visibility, or formal quality of epistemic output supports a broader claim about knowledge, epistemic capacity, or generative improvement only when the research design identifies the complementary processes through which the output is evaluated, interpreted, verified, integrated, mobilized, and retained.*

Proposition 22.652 supplies a common evidential discipline for the eight research domains below. It prevents abundant traces from being treated as abundant knowledge and prevents changes in easily observed output from standing in for less visible changes in orientation, judgment, or long-horizon generative capacity.

Table 22.14 summarizes the principal research domains developed in this section.

22.14.1 Knowledge Abundance

Research on knowledge abundance begins by specifying what has become abundant. Chapter 17 distinguished informational abundance, epistemic-generation abundance, AI-mediated abundance, and symbolic abundance because each can increase while other epistemic capacities remain scarce. The research programme should preserve that decomposition. Counts of documents, tokens, datasets, publications, model outputs, patents, repository objects, or accessible records can establish growth in a specified output class. They do not by themselves establish growth in warranted knowledge, usable understanding, or collective problem-solving capacity.

A first empirical task is therefore to construct a typed abundance series. The unit should identify the object being counted, the access condition, the production or replication process, and the receiving field. A corpus can become larger while remaining inaccessible to a relevant population. Searchable records can expand while linguistic

Table 22.14: Principal research domains in the epistemic economy

Research domain	Primary object	Principal research burden
Knowledge abundance	Stocks and flows of informational, symbolic, and candidate epistemic objects	Distinguish production from warranted incorporation and locate complementary bottlenecks
Attention scarcity	Notice, processing depth, continuity, and institutional response capacity	Identify functional attention limits, displaced objects, queues, filters, and temporal incidence
Question selection	Formation, ranking, continuation, and abandonment of inquiry trajectories	Reconstruct candidate-question sets, selection mechanisms, opportunity costs, and hidden exclusions
Aesthetic judgment	Historically formed evaluative cues concerning elegance, depth, surprise, and generative promise	Separate judgment from outcome and study calibration, formation, disagreement, and institutional conversion
Epistemic orientation	Sustained direction of inquiry under multiple plausible paths	Trace priority formation, revision, commitment, path dependence, and orientation failure
Knowledge capital	Persistent mobilizable epistemic capacity and its carriers	Identify accumulation, access, control, depreciation, transfer, and recursive expansion
Unequal generative capacity	Differences in the ability to generate, evaluate, connect, and sustain future inquiry	Decompose capability bundles, complementary conditions, persistence, and conversion into wider advantage
AI-mediated knowledge production	Human-AI production chains and capability stacks	Attribute functions, verification burdens, dependence, learning effects, concentration, and net generative consequences

or technical barriers continue to exclude use. An AI system can increase candidate-output volume while expert review becomes the binding bottleneck. The same quantity should therefore be paired with measures of accessibility, verification load, integration capacity, and actual uptake where those dimensions are material to the research claim.

Definition 22.653 (Abundance-conversion profile). An *epistemic-abundance conversion profile* records how an increase in a specified informational, symbolic, or candidate epistemic supply is converted, or fails to be converted, into verified understanding, practical use, preserved knowledge, institutional learning, or later generative capacity across identified receiving positions.

Definition 22.653 makes abundance research comparative. The same increase in accessible papers can produce high conversion where synthesis institutions, disciplinary expertise, translation, replication capacity, and stable research time are available, and low conversion where those complements are absent. Researchers can compare institutions, regions, disciplines, organizations, or periods with similar output growth but different conversion architectures. Such designs help identify which complements mediate the relation between abundance and epistemic gain.

Time also matters. An output can be weakly useful at publication and highly useful after later methods, data, or problems make it interpretable. Conversely, a rapidly expanding information stream can create temporary overload before tools and institutions adapt. Longitudinal research should therefore distinguish immediate abundance effects from later integration and re-epistemization. Preservation infrastructure becomes part of abundance research because uncurated abundance can become practically inaccessible over time even when the raw records survive.

A useful falsification condition follows. If increased output is accompanied by no

identifiable change in access, verification, integration, problem-solving, preservation, or later generative capacity, a claim that the field has become epistemically more capable should be weakened even where production metrics rise sharply. Conversely, modest output growth can coexist with substantial capability improvement when indexing, standards, synthesis, translation, or institutional learning make existing knowledge more mobilizable.

Proposition 22.654 (Abundance-conversion condition). *An empirical claim that epistemic abundance expands a field's effective knowledge capacity should identify the conversion pathway connecting increased epistemic supply to warranted and mobilizable capability, together with the complementary resources and bottlenecks that condition that pathway.*

22.14.2 Attention Scarcity

Attention scarcity becomes researchable when attention is decomposed by function. Chapter 17 distinguished noticing, sustained examination, comparison, deliberation, monitoring, and coordinated response. These functions have different resource requirements and are only partially substitutable. Research designs should therefore avoid representing attention solely through exposure, clicks, viewing time, citation counts, or message frequency unless the intended inference concerns exactly that observable layer.

Empirical work can begin with an attention pathway: which objects become eligible for notice, which filters rank them, which positions receive them, how much processing depth follows, how long attention persists, what competing objects are displaced, and whether attention reaches a consequential decision or learning process. Digital systems sometimes provide detailed event traces, but organizational records, meeting agendas, review queues, grant panels, inspection schedules, clinical triage records, editorial processes, and ethnographic observation can reveal attention allocation in settings where clickstream measures are irrelevant.

Definition 22.655 (Attention-bottleneck trace). *An attention-bottleneck trace identifies a stage in an epistemic process at which the rate or complexity of incoming objects exceeds the practically available capacity for the required form of notice, interpretation, comparison, deliberation, monitoring, or response, and records the queues, delays, filters, omissions, substitutions, and displaced alternatives produced by that mismatch.*

The trace in Definition 22.655 helps distinguish scarcity from preference. A queue can lengthen because the receiving institution lacks qualified reviewers, because decision authority is centralized, because reporting volume has expanded, because filtering rules generate false positives, or because other priorities consume available capacity. These mechanisms imply different interventions and different distributions of burden.

Attention scarcity also has incidence. An institution can manage aggregate workload by systematically delaying weakly represented groups, novel questions, maintenance tasks, low-frequency risks, or problems whose benefits are temporally distant. Average response time can therefore conceal structured neglect. Research should examine whose signals are filtered, which classes of object repeatedly fail to cross escalation thresholds, and whether delayed attention changes later feasibility or harm.

Experimental or quasi-experimental designs can sometimes evaluate changes in

ranking, triage, staffing, summarization, meeting structure, or automated filtering. Yet improved throughput is insufficient as a success criterion when the intervention alters error composition, depth of processing, learning, or accountability. Qualitative work is often needed to determine whether reduced review time reflects efficiency, shallower judgment, better prior screening, or transferred labor elsewhere in the system.

Proposition 22.656 (Attention-scarcity identification condition). *A claim of consequential attention scarcity should identify the required attention function, the receiving position, the competing load, the allocation or filtering mechanism, and the consequence of delay, omission, insufficient depth, or displaced attention within a specified horizon.*

22.14.3 Question Selection

Question selection is one of the least visible but potentially most consequential allocation processes in an epistemic economy. Research usually observes projects after questions have been stabilized enough to enter proposals, papers, datasets, laboratories, or organizational agendas. Chapter 17 located an earlier sequence involving encounter, salience, wonder, curiosity, conceptual articulation, and sustained inquiry. The research challenge is to recover enough of this prehistory to study why some possible questions acquire resources and continuity while others disappear before leaving durable traces.

A question-selection study should distinguish at least three sets: questions that become thinkable within the available conceptual and linguistic repertoire; questions that are articulated and communicated; and questions that receive sufficient support to become sustained inquiry. Each boundary can be shaped by different mechanisms. Educational background influences what anomalies are recognizable. Disciplinary vocabularies affect articulation. Funding rules, supervisors, organizational mandates, publication expectations, data access, and time horizons affect continuation.

Definition 22.657 (Question-selection trace). *A question-selection trace reconstructs the candidate questions, encounters, salience conditions, conceptual resources, evaluative criteria, institutional filters, resource commitments, continuation decisions, abandoned alternatives, and subsequent revisions through which a specified inquiry trajectory acquires or loses sustained support.*

Such traces can be assembled from notebooks, grant applications, rejected proposals, meeting records, preregistrations, correspondence, interviews, version histories, laboratory records, archival material, and retrospective accounts, with appropriate caution about memory and survivorship bias. The objective is not to reconstruct every unrealized thought. It is to identify patterned selection where institutions repeatedly privilege or exclude classes of question.

Question selection has an opportunity-cost dimension. Funding one programme can crowd out another; committing a laboratory to one instrument can narrow future feasible projects; choosing a standardized benchmark can redirect an entire technical community toward measurable tasks. The consequence can be productive specialization, path dependence, or both. Research should therefore follow how early selections alter later encounter opportunities, skill formation, infrastructure, datasets, prestige, and the cost of switching direction.

Negative evidence is especially important. If an alleged institutional bias toward

a type of question is claimed, researchers should seek comparable questions that entered the same selection process and received different outcomes, examine the stated and enacted criteria, and test whether topic, method, applicant position, expected payoff, legibility, or other variables better explain the pattern. A selection mechanism should not be inferred merely because an unfunded question later appears important.

Proposition 22.658 (Question-selection mechanism condition). *A research claim about systematic question selection should identify a recurrent mechanism connecting candidate inquiry to differential continuation, together with evidence about relevant alternatives and the later consequences of selection for epistemic trajectories, rather than inferring the mechanism solely from the observed portfolio of completed research.*

Question-selection research can also examine the value of protected exploratory space. Institutions sometimes maintain small grants, sabbaticals, exploratory laboratories, archives, cross-disciplinary programmes, or discretionary time precisely because the ex ante value of a question is difficult to establish. Comparative research can ask whether such arrangements increase later diversity, problem discovery, or adaptive capacity, and under what conditions they become unproductive slack or symbolic programmes without actual continuity.

22.14.4 Aesthetic Judgment

Aesthetic judgment enters epistemic research where qualities such as elegance, beauty, depth, surprise, simplicity, coherence, or generative promise influence what researchers pursue before decisive evidence is available. Chapter 17 treated these judgments as historically formed orientations rather than universal indicators of truth. The research task is consequently neither to dismiss them as subjective preference nor to convert them into direct measures of epistemic quality. It is to study how such judgments are formed, distributed, calibrated, contested, and converted into consequential allocations of attention and resources.

An empirical programme can examine judgment at several levels. Individual-level studies can investigate whether experienced and novice researchers rank candidate problems differently and how those rankings change with training or exposure. Group-level studies can compare agreement within and across disciplinary communities. Historical studies can reconstruct changes in what a field considered elegant or promising. Institutional studies can examine how aesthetic language enters peer review, hiring, prize systems, seminars, grant deliberation, or informal mentorship. Experimental work can vary presentation, complexity, symmetry, explanatory compression, or novelty cues while holding substantive content as constant as possible, although ecological validity should remain explicit.

Definition 22.659 (Aesthetic-judgment research record). *An aesthetic-judgment research record documents the epistemic object being judged, the evaluative cues invoked, the judging position and its training history, the comparison set, the degree and form of confidence, the institutional consequence of the judgment, subsequent evidential development, and the conditions under which the judgment is revised.*

The record makes calibration research possible. Aesthetic judgment can be studied prospectively by recording judgments before outcomes are known and then observing which projects, conjectures, designs, or interpretations later prove fruitful under specified criteria. Retrospective studies are easier but risk selecting only celebrated

successes and reconstructing their earlier reception through later prestige. Archival evidence and pre-outcome records are therefore especially valuable.

Calibration should remain multidimensional. A problem can be judged elegant and later prove technically sterile, or initially awkward and later open a large research programme. A theory can possess explanatory compression while fitting evidence poorly. A surprising result can be generative because it exposes hidden assumptions, or merely reflect error. Research should therefore compare aesthetic judgments with several later outcomes: empirical adequacy, explanatory reach, methodological reuse, problem generation, cross-domain transfer, pedagogical value, or durable community formation. Different fields can legitimately weight these outcomes differently.

Institutional conversion also deserves study. Aesthetic judgments become economically consequential when they influence funding, access to instruments, publication, hiring, collaboration, or visibility. Unequal authority over these judgments can create path dependence even without deliberate exclusion. Researchers should reconstruct who has standing to make consequential judgments, which vocabularies are recognized, how dissent is handled, and whether alternative evaluative communities remain viable.

Proposition 22.660 (Aesthetic-judgment calibration condition). *A claim that an aesthetic criterion contributes to epistemically productive selection should compare recorded judgments with specified later epistemic outcomes across an appropriate comparison set and historical horizon, while preserving disagreement, selection effects, and cases in which the criterion fails.*

22.14.5 Epistemic Orientation

Epistemic orientation concerns the capacity to establish and revise direction among many plausible questions, methods, interpretations, and practical priorities. It becomes increasingly important when answer production is abundant because the binding scarcity can move from producing candidate solutions toward deciding which problems deserve sustained inquiry, what evidence should change direction, and when a trajectory should be continued, combined, suspended, or abandoned. Orientation is therefore temporal and comparative rather than reducible to a one-time ranking.

Research on orientation should reconstruct sequences of commitment. A laboratory, organization, discipline, or individual researcher encounters many possible directions but can sustain only some. Orientation is visible in portfolios, staffing, infrastructure, reading and citation patterns, meeting agendas, grant renewals, benchmark choice, archive use, collaborations, and the questions repeatedly protected from short-horizon pressure. These traces can be combined with interviews and contemporaneous records to reconstruct the reasons attached to direction changes.

Definition 22.661 (Epistemic-orientation trajectory). *An epistemic-orientation trajectory is the historically ordered sequence through which a position or institution prioritizes, sustains, revises, combines, or abandons inquiry directions, together with the evidential signals, evaluative judgments, resource conditions, institutional constraints, and external events associated with those changes.*

Orientation quality cannot be inferred solely from persistence. Long commitment can support deep work where feedback is slow, while it can also sustain a failing pro-

gramme because prestige, sunk cost, or infrastructure makes exit difficult. Frequent redirection can reflect responsiveness or short-horizon instability. Research should therefore examine whether orientation mechanisms are capable of both continuity and revision under the relevant environment.

One empirical strategy is to identify orientation events: moments when new evidence, an anomaly, a technological change, a social need, an unexpected encounter, a funding shift, or a conceptual innovation plausibly altered the feasible or desirable direction of inquiry. Researchers can then compare organizations or communities facing similar events but exhibiting different responses. Historical and process-tracing methods are valuable because orientation often depends on cumulative interpretation rather than a single measurable treatment.

Orientation can also be distributed. A field may possess plural communities pursuing different hypotheses, such that collective orientation emerges from portfolio diversity even when each local group is relatively committed. Research should therefore specify the level of analysis. Diversity that appears fragmented at the laboratory level can be adaptive at the field level, while apparent diversity at the publication level can conceal dependence on the same datasets, benchmarks, funding sources, or conceptual assumptions.

Proposition 22.662 (Orientation-adaptability condition). *A claim that an epistemic orientation is generatively adaptive should identify the mechanisms that support continuity long enough for difficult inquiry to mature and the mechanisms that permit revision when materially relevant evidence, constraints, or possibilities change.*

22.14.6 Knowledge Capital

Knowledge capital was defined in Chapter 17 as a persistent and mobilizable configuration of epistemic objects, capacities, relations, and enabling infrastructures that affects later productive or epistemic possibility. Research on knowledge capital therefore requires more than measuring accumulated publications, credentials, patents, datasets, or expenditure. The research object is the historically carried capacity that remains usable under identifiable conditions.

A first task is carrier identification. Knowledge capital can be carried by persons, teams, languages, routines, archives, software, instruments, datasets, standards, institutional memory, professional networks, libraries, laboratories, or combinations of these. Carriers differ in depreciation, transferability, exclusion, maintenance cost, and dependence on complementary relations. A skilled team can dissolve; a dataset can become unusable when documentation disappears; a standard can retain value only while a community maintains compatible practice; a library can preserve records that remain economically dormant until later questions make them relevant.

Definition 22.663 (Knowledge-capital mobilization profile). *A knowledge-capital mobilization profile records the accumulated epistemic configuration, its carriers, access and control relations, complementary skills and infrastructures, maintenance requirements, depreciation or obsolescence risks, conditions of practical use, realized applications, and contribution to subsequent epistemic or productive capacity over a specified horizon.*

The distinction between stock and mobilization is central. An organization can possess extensive archives yet lack the staff or indexing required to use them. A country can produce many graduates while failing to provide institutions in which their

knowledge becomes productive. Open knowledge can be widely accessible while remaining difficult to mobilize because complementary language, compute, instrumentation, or tacit competence is scarce. Conversely, shared infrastructure can permit many positions to mobilize a knowledge-capital configuration they do not own.

Research should also study depreciation and maintenance. Knowledge can lose practical value when standards change, software dependencies break, personnel leave, tacit routines disappear, provenance is lost, or institutional trust declines. Maintenance work—documentation, curation, replication, teaching, archiving, migration, standard revision, and succession—can therefore be part of capital reproduction. These activities are often poorly represented by novelty-oriented output metrics even though they condition whether accumulated capability remains mobilizable.

Recursive expansion is another empirical target. Longitudinal designs can test whether existing epistemic capacity materially improves later generation, selection, verification, integration, or preservation. Network analysis can examine whether accumulated relations broaden access to collaborators and information. Historical studies can trace how laboratories, universities, firms, or public institutions convert earlier capability into new infrastructure. Yet recursive expansion should be distinguished from simple scale growth: larger organizations can accumulate records without increasing learning capacity, and concentrated capital can produce diminishing or negative generative returns when closure, bureaucracy, or path dependence narrows inquiry.

Proposition 22.664 (Knowledge-capital identification condition). *An empirical claim of knowledge-capital accumulation should identify a persistent carrier, conditions of mobilization, a historically consequential capacity effect, and the mechanism through which the accumulated configuration alters later epistemic or productive possibility; accumulated symbolic objects alone are insufficient.*

22.14.7 Unequal Generative Capacity

Unequal generative capacity concerns differences in the practical ability of positions to create, recognize, test, connect, preserve, and continue epistemic possibilities. This is broader than unequal information possession and narrower than an unqualified ranking of intelligence or worth. The relevant capacity is field-, task-, relation-, and horizon-specific. It can be individual or collective, and it often depends on complementary resources that sit outside the person conventionally credited with generation.

A research programme should decompose generative capacity into observable or reconstructible components. Depending on the field, these can include encounter opportunity, conceptual repertoire, question-formation capacity, methodological skill, access to instruments or compute, verification capacity, time continuity, collaborative relations, institutional standing, funding, language, archives, ability to attract attention, and capacity to preserve or transmit results. The decomposition should be adapted to the research object rather than imposed as a universal index.

Definition 22.665 (Generative-capacity distribution profile). *A generative-capacity distribution profile records the task-relevant epistemic capacities, complementary resources, infrastructural access, relational supports, institutional standing, temporal security, and practical alternatives available to compared positions, together with the mechanisms through which these conditions affect their ability to open and sustain*

future epistemic possibilities.

This profile permits several distinct empirical questions. Researchers can ask whether formal access to the same information produces different generative outcomes because complementary capacities differ; whether institutional membership changes the probability that a question becomes sustained inquiry; whether access to high-quality mentorship or computation produces cumulative advantage; whether public infrastructure narrows capability gaps; or whether a new technology expands absolute capability for many positions while increasing relative differences in frontier generativity.

Persistence is especially important. Temporary asymmetry can support productive specialization, while persistent asymmetry can become self-reinforcing through cumulative learning, reputation, control of infrastructure, privileged access to data, attraction of collaborators, or superior ability to obtain further resources. Longitudinal designs should therefore trace the mechanism carrying the difference across time. Intergenerational research can examine how educational opportunity, language, institutional access, family resources, community networks, and public knowledge infrastructures transmit or interrupt accumulated epistemic advantage.

The section should also preserve causal humility. Superior output by one position does not prove greater underlying generative capacity if the position receives better infrastructure, selective inputs, greater support, or preferential attention. Likewise, equal observed output does not establish equal capacity when one position operates under higher constraints. Research should distinguish realized performance from the conditions that make performance possible.

Proposition 22.666 (Generative-capacity asymmetry condition). *A claim of consequential unequal generative capacity should specify the epistemic functions being compared, the complementary conditions under which they are exercised, the mechanism producing or sustaining the difference, and the later possibility set affected by that difference.*

The profile also connects to power, justice, and exploitation without collapsing into them. Unequal generative capacity can exist without domination, injustice, or appropriation. It becomes power-relevant when converted into effective control over another position's access or trajectory; justice-relevant when assessed through explicit normative premises; and exploitation-relevant when another position's generativity is appropriated through the stronger mechanism developed in Section 22.13. Maintaining these distinctions allows empirical work to identify asymmetry before assigning stronger relational diagnoses.

22.14.8 AI-Mediated Knowledge Production

AI-mediated knowledge production brings the preceding research problems into one rapidly changing production architecture. Artificial systems can expand candidate generation, retrieval, translation, summarization, coding, classification, simulation, pattern detection, drafting, and other epistemic functions. Their significance depends on how these functions enter a wider chain involving human purposes, data, infrastructure, prompts or task specifications, retrieval, tool use, evaluation, verification, institutional authorization, preservation, and responsibility. The research unit should therefore usually be a production configuration rather than an isolated model output.

A first task is functional decomposition. Researchers should identify which stages

are machine-mediated, which remain human-led, where tasks are jointly constituted, and where handoffs occur. This matters because the same headline capability can support different institutional relations. Automated drafting can free expert time for judgment, or it can increase review load by multiplying low-cost outputs. Search and summarization can widen access, or they can concentrate reliance on opaque ranking systems. Coding assistance can accelerate production while weakening local understanding if users lose the ability to verify or maintain generated systems. The direction of the effect is an empirical question.

Definition 22.667 (AI-mediated epistemic production chain). An *AI-mediated epistemic production chain* records the sequence of human, artificial, organizational, and infrastructural functions through which a candidate epistemic object is specified, generated, retrieved, transformed, evaluated, verified, authorized, integrated, used, preserved, and revised, together with the ownership, access, responsibility, and dependency relations at each consequential stage.

Definition 22.667 makes several research questions tractable. Productivity studies can measure changes in time, cost, output, error, or task completion while also recording verification burden and downstream correction. Learning studies can distinguish temporary performance gains from changes in independent human capability. Organizational studies can examine whether AI redistributes expertise toward supervisors, reviewers, integrators, or infrastructure specialists. Distributional studies can compare positions with different model access, data, compute, interfaces, languages, or support. Historical studies can trace how workflows become reorganized around AI and whether dependence persists when systems change.

Provenance and attribution also require careful design. An epistemic artifact can incorporate prior human knowledge, retrieved sources, proprietary databases, user specifications, model-generated transformations, tool outputs, and later editorial judgment. Research on contribution should therefore avoid a binary human-versus-machine attribution where the production process is distributed. Provenance records, version histories, source citations, system logs, and workflow observation can help identify which contributions are materially consequential and which remain difficult to recover.

Verification is a second major object. When generation becomes cheaper, checking can become relatively more expensive. Researchers should measure review time, error discovery, disagreement, escalation, and the types of claims for which direct verification is infeasible. The relevant comparison is not simply AI accuracy versus human accuracy; it can involve human-only, AI-only where institutionally permitted, human-with-AI, team-with-AI, or differently provisioned AI-mediated configurations. The comparison conditions should state access, time, tools, domain expertise, and consequence of error.

Learning and capability formation form a third object. Assistance can create scaffolding that accelerates learning, expose users to new methods, and widen access to expertise. It can also externalize functions that users cease to practice. Longitudinal studies are therefore necessary when the research claim concerns human capability rather than immediate task performance. Measures can include transfer to unassisted tasks, ability to detect errors, conceptual explanation, novel problem formation, retention, maintenance capability, and capacity to revise AI-supported work when conditions change.

A fourth object is concentration. Models, compute, proprietary data, evaluation

infrastructure, interfaces, and organizational integration can be distributed differently. Research should identify which layer is consequential for a particular function and whether alternatives are practically substitutable. Concentration becomes more consequential when access to a weakly substitutable layer conditions entry, verification, portability, or future learning. This inquiry provides an empirical bridge to Section 513, which examines the stronger case of AI and radical capability asymmetry across the wider economy.

Proposition 22.668 (AI-mediated net-generativity condition). *A claim that AI-mediated knowledge production expands epistemic generativity should evaluate the production gains together with changes in verification burden, human and collective learning, question formation, orientation, dependence, access, preservation, and the distribution of future generative capacity over the relevant horizon.*

Proposition 22.668 prevents immediate throughput from serving as the sole measure of epistemic improvement. A system can produce more candidate material while narrowing question diversity, increasing verification dependence, or concentrating the infrastructures required for future production. It can also reduce barriers, broaden participation, preserve expertise, and create new combinations that would otherwise remain inaccessible. The research programme should be capable of finding either pattern.

The eight domains developed in this section can now be integrated into a common empirical logic. Knowledge abundance concerns the changing supply of epistemic objects and the conversion conditions required for warranted use. Attention scarcity locates bottlenecks in selective processing. Question selection reconstructs the prehistory of sustained inquiry. Aesthetic judgment and epistemic orientation examine evaluative and directional capacities operating under incomplete evidence. Knowledge capital follows persistent mobilizable capability across time. Generative-capacity analysis examines its unequal distribution. AI-mediated knowledge production studies how these relations are reorganized when artificial systems enter epistemic production chains.

Proposition 22.669 (Epistemic-economy research-programme closure). *Within the GRE research programme, claims about epistemic-economic change should be evaluated through the coupled analysis of production, selection, attention, judgment, orientation, accumulation, access, verification, preservation, and future generative capacity, with each stronger claim tied to an identifiable mechanism and a stated evidential horizon.*

Proposition 22.669 completes the section's research architecture. It also establishes the boundary for the next section. AI-mediated epistemic production can be studied within the epistemic economy while its consequences remain primarily related to knowledge generation, evaluation, learning, and access. Where AI-mediated capability differences become persistent, multidimensional, infrastructure-supported, weakly substitutable, and consequential for productive capacity, bargaining, institutional participation, labor, ownership, or future economic possibility more broadly, the research object exceeds epistemic economy alone. Section 513 therefore turns to research on AI and radical capability asymmetry.

22.15 Research on AI and Radical Capability Asymmetry

The role of this section is to convert the artificial-intelligence and radical-capability-asymmetry architecture developed in Chapter 18 into a cumulative research programme. The objective is not to rank humans and artificial systems on one general scale, nor to infer economy-wide transformation from isolated benchmark gains. It is to identify when AI-mediated capability differences become practically realized, multidimensional, persistent, weakly substitutable, institutionally embedded, and consequential for production, knowledge, labor, ownership, dependency, participation, and future economic possibility. The discussion proceeds through capability measurement, knowledge asymmetry, productive abundance, labor transformation, ownership of productive intelligence, dependency, human participation, generative coexistence, and long-horizon economic transformation. The method is relational, longitudinal, comparative, and mechanism-centered. It combines task and workflow measurement, organizational observation, access and infrastructure mapping, provenance and audit records, labor and income data, institutional analysis, interviews and ethnography, longitudinal capability assessment, comparative case analysis, and scenario-sensitive historical reconstruction.

AI research poses an unusually strong inference problem because technical performance, economically usable capability, organizational control, and long-horizon transformation occupy different analytical levels. A model may perform strongly on a benchmark while remaining unavailable, unaffordable, untrusted, legally unusable, or poorly integrated into a consequential workflow. A system with lower frontier performance can become economically decisive when it is repeatedly embedded in a high-frequency process. An observed productivity gain can reflect complementarity rather than substitution. A decline in one human task can coexist with expansion of human responsibility elsewhere in the workflow. Concentrated ownership can coexist with broad access, while broad nominal access can coexist with concentrated effective control. Research must therefore reconstruct the configuration through which technical capacity becomes economic capacity before stronger conclusions are drawn.

Definition 22.670 (AI capability-asymmetry research profile). An *AI capability-asymmetry research profile* is a structured record of the human, artificial, organizational, and infrastructural positions being compared; the task or operation family; the relevant capability dimensions; access and complementary resources; verification and authorization conditions; substitutability and fallback options; ownership and control relations; temporal persistence; distributional incidence; affected participation pathways; and the evidential horizon over which an AI-mediated capability difference is claimed to matter economically.

Definition 22.670 makes comparison conditional on a declared research object. Speed in drafting, accuracy in classification, access to domain records, capacity for simulation, ability to coordinate tools, institutional authority, and capacity to sustain a relation are different dimensions. They can interact without becoming commensurable. A profile can therefore contain quantitative measures, partial orderings, qualitative descriptions, and explicit unknowns. The research burden is to show which dimensions matter for the specified economic process and how they combine.

Proposition 22.671 (Radical-asymmetry identification condition). An *AI-mediated ca-*

Table 22.15: Principal research domains for AI and radical capability asymmetry

Research domain	Primary object	Principal research burden
Capability measurement	Practically realizable human, artificial, and collective capability profiles	Separate benchmark performance from usable capacity and state task, complement, access, verification, and horizon conditions
Knowledge asymmetry	Unequal ability to obtain, generate, interpret, verify, and mobilize consequential knowledge	Distinguish information volume from operational epistemic position and trace conversion into later capability
Productive abundance	AI-mediated expansion of feasible output relative to selected scarce inputs	Identify where scarcity is relaxed, where bottlenecks migrate, and who can convert abundance into durable capacity
Labor transformation	Changes in tasks, workflows, occupations, income relations, skills, and participation	Follow transition mechanisms rather than infer employment effects from technical automation alone
Ownership of productive intelligence	Control across models, compute, data, platforms, infrastructure, interfaces, and access rights	Map effective control, portability, governance, and weakly substitutable bottlenecks rather than nominal title alone
Dependency	Reliance on AI-mediated capability for consequential activity or future alternatives	Measure switching, fallback, portability, verification, learning, and continuity under altered access or terms
Human participation	Human capacity to contribute to knowledge, decisions, institutions, care, community, and culture	Separate residual presence from practical influence over problem framing, verification, revision, and institution making
Generative coexistence	Human–AI configurations that reproduce or expand multiple participants’ future generative capacities	Test complementarity, distribution, contestability, maintenance, and anti-foreclosure conditions
Long-horizon transformation	Coupled trajectories of capability, labor, ownership, institutions, knowledge, dependency, and participation	Compare path-dependent scenarios without converting uncertain trajectories into deterministic forecasts

pability difference warrants the stronger description of radical capability asymmetry only when the research design identifies the relevant capability dimensions, demonstrates their practical realization in the observed configuration, establishes persistence or recurrent reproduction over the stated horizon, evaluates substitutability and countervailing capabilities, and shows a material effect on the range, scale, timing, cost, reliability, control, or continuity of economically consequential operations available to the compared positions.

Proposition 22.671 is the section’s principal safeguard. A benchmark lead, a dramatic demonstration, or a short-lived access difference can motivate inquiry without establishing radical asymmetry. The stronger claim requires a mechanism connecting capability difference to an altered possibility structure. This discipline also keeps capability analysis distinct from power, justice, and exploitation. Radical asymmetry can become power-relevant through the mechanisms studied in Section 22.11, justice-relevant through the normative research architecture of Section 22.12, and exploitation-relevant only when the stronger appropriation and generative-deterioration mechanisms of Section 22.13 are supported.

Table 22.15 summarizes the principal research domains developed below.

22.15.1 Capability Measurement

Capability measurement is the entry point because later claims depend on the quality of the comparison. A useful research design begins by decomposing the activity being studied. The unit can be a task, a workflow stage, an occupation, an organizational process, a decision sequence, a research practice, or a collective generative process. The chosen unit determines which capabilities matter. Language generation may be decisive for one workflow and peripheral for another. High-speed search can matter where candidate discovery is binding but matter less where verification or authorization dominates. Tool use can transform one production sequence while leaving another constrained by physical access, trust, regulation, or human relation.

Benchmark scores can be informative inputs, yet they should usually be treated as measurements of a delimited technical performance under specified conditions. Economic capability requires a second layer of observation concerning practical availability. Researchers should record cost, latency, tool access, language coverage, context availability, data rights, hardware, connectivity, reliability, interface friction, organizational integration, supervision requirements, and the consequences of error. For human participants, corresponding conditions include education, domain experience, fatigue, time, access to records and tools, social support, authority, and the possibility of learning from repeated use. Comparisons should therefore avoid placing an optimized artificial system against an under-resourced human position without recording the asymmetry in complements.

Definition 22.672 (Capability-realization protocol). *A capability-realization protocol specifies the operation being measured, the participating positions, technical and institutional conditions, available complements, permitted tools, time and resource constraints, verification requirements, error consequences, repetition structure, learning opportunities, and rules for determining whether an observed performance is practically reproducible in the economic configuration of interest.*

The protocol in Definition 22.672 allows several kinds of measurement to coexist. Laboratory studies can isolate selected mechanisms. Field studies can estimate performance under ordinary organizational conditions. Longitudinal studies can observe learning, adaptation, model updates, or skill atrophy. Comparative studies can vary access and complements. The research question determines which design is appropriate. No single design should silently stand in for every other level.

Measurement should also distinguish individual from collective capability. A human–AI team can outperform either component in isolation because division of labor, verification, tool orchestration, or institutional authorization produces a collective capacity. Conversely, a high-performing model can lower collective performance if its outputs are difficult to verify, if users over-rely on them, or if coordination costs rise. Team-level measures should therefore record interaction patterns and error-correction structure rather than attribute all observed output to the nominally most capable component.

Proposition 22.673 (Capability-comparison discipline). *A broader claim about AI capability should not be inferred from a local performance advantage unless the study specifies the domain over which the advantage is expected to generalize, the complements required for realization, the countervailing capabilities excluded from the measure, and the evidence supporting persistence across repeated use or changing conditions.*

This proposition is especially important when systems change rapidly. A study can remain valid as evidence about a historical configuration while becoming a poor description of a later one. Version, date, access tier, tool environment, and organizational context should therefore be recorded wherever they materially affect the result. The research programme treats historical specificity as part of measurement rather than as noise to be removed.

22.15.2 Knowledge Asymmetry

Knowledge asymmetry concerns more than unequal possession of information. AI-mediated systems can alter who can retrieve, generate, compare, translate, summarize, model, interpret, and verify epistemic material. The relevant economic effect depends on which of these functions become operationally available and how they enter later decisions. A position can receive many machine-generated answers while remaining unable to judge their reliability. Another can possess less raw information but stronger domain judgment, provenance access, or verification infrastructure. Research should therefore represent epistemic position as a bundle of functions rather than a count of accessible documents or generated tokens.

Section 22.14 supplies the general epistemic-economy architecture. The present subsection narrows the object to asymmetry that is sufficiently connected to AI-mediated capability differences to alter economic possibilities. A useful design identifies at least four stages: access to candidate epistemic material; capacity to generate or transform it; capacity to evaluate and verify it; and capacity to mobilize it inside an institution or productive process. The stages can be distributed across different actors. A worker may receive recommendations generated by a system controlled elsewhere. A firm may possess model access but lack proprietary domain data. A public institution may have information but not the technical capacity to audit a model used by a contractor. These are different knowledge asymmetries.

Definition 22.674 (AI-mediated knowledge-asymmetry dossier). An *AI-mediated knowledge-asymmetry dossier* records the compared positions' access to relevant epistemic material, generation and retrieval capacity, interpretive and verification resources, provenance visibility, update frequency, model and data access, institutional authority to act on outputs, learning effects, and the mechanism through which these differences alter later economic action or feasible alternatives.

The dossier supports several empirical strategies. Researchers can compare decision quality before and after AI access, but should also measure which groups improve, which remain verification-constrained, and whether gains persist without continued assistance. Organizational process tracing can identify whether epistemic advantage is retained at the point of model ownership, at data access, at integration, at final authorization, or at the capacity to contest outputs. Audit studies can compare what different positions can discover about the same system. Longitudinal education or workplace studies can examine whether AI access produces durable knowledge formation, temporary performance support, or differentiated learning trajectories.

Knowledge asymmetry can also be recursively amplified. Better access to AI can improve coding, search, analysis, and organizational design, which may in turn improve data collection and the capacity to adopt later systems. Yet the opposite pattern is also possible: broadly available tools can reduce entry barriers, diffuse expertise, and allow smaller positions to approximate capabilities previously concentrated in

larger organizations. The direction is empirical.

Proposition 22.675 (Knowledge-asymmetry conversion condition). *A claim that AI-mediated knowledge asymmetry produces a broader capability asymmetry should identify the conversion mechanism through which epistemic differences become practically usable differences in production, bargaining, coordination, verification, institutional influence, learning, or future option generation.*

Without that conversion evidence, unequal information or model performance can remain an important descriptive fact without establishing the stronger economic consequence. The proposition also protects against circular reasoning in which capability is inferred from knowledge advantage and knowledge advantage is then inferred from observed capability.

22.15.3 Productive Abundance

AI can lower the marginal cost or time required for selected symbolic, computational, analytic, design, or coordination operations. Research on productive abundance asks what becomes abundant relative to which previously scarce input, which new constraints become binding, and how the resulting gains are distributed. The unit should therefore be a production relation rather than an abstract statement that “intelligence” or “content” has become abundant.

A first empirical task is to identify the relaxed constraint. Drafting time, coding time, translation capacity, simulation throughput, candidate generation, customer-response capacity, or design exploration can each change differently. A second task is to identify the new bottleneck. Verification, data quality, compute, energy, trusted attention, institutional authorization, distribution, demand, physical implementation, skilled supervision, or coordination may become relatively more important. A third task is incidence: who obtains the lower cost, who bears new review or integration burdens, and who can convert the expanded output into durable capability, income, or control.

Definition 22.676 (AI productive-abundance profile). *An AI productive-abundance profile records the output or operation whose feasible supply expands, the scarce input whose constraint is relaxed, the complementary inputs required for realization, the bottlenecks that become relatively more binding, the positions able to appropriate or use the expansion, the new verification or maintenance burdens, and the resulting changes in future productive capacity.*

Definition 22.676 allows abundance to be local. Cheap generation of software code does not make software maintenance, security, product judgment, or user trust abundant. Cheap text production does not make reader attention abundant. Rapid simulation does not guarantee better models of reality. A useful study therefore measures substitution and complementarity across inputs rather than only the volume of final artifacts.

Productive abundance can alter market structure. Lower production costs can facilitate entry, expand variety, or allow previously infeasible services. They can also increase returns to distribution, proprietary data, brand, infrastructure, or platform control if those layers become the new bottlenecks. Research can compare industries or organizations with different complementary structures to identify which pattern appears and under what conditions.

Proposition 22.677 (Scarcity-relocation condition). *An empirical claim of AI-mediated productive abundance should identify both the constraint that has been relaxed and the consequential scarcities that remain or emerge, because economic transformation depends on the configuration of relocated bottlenecks rather than on output expansion alone.*

The proposition links productive abundance to capability asymmetry. If only some positions control the new bottleneck, a technology that broadly lowers one production cost can still deepen asymmetry elsewhere in the stack. If alternatives are accessible and complements diffuse, the same technical change can reduce asymmetry. The research programme should be designed to detect both possibilities.

22.15.4 Labor Transformation

Labor research should distinguish technical automation, task reallocation, workflow redesign, occupational change, employment incidence, wage effects, skill formation, bargaining position, and participation. These objects can move in different directions. An occupation can remain while its internal task composition changes. Productivity can rise while employment expands, contracts, or redistributes across firms. Workers can become more capable with AI while becoming more dependent on a platform. A task can disappear while new verification, coordination, or client-facing work emerges. The research design should therefore follow the transition mechanism rather than infer labor outcomes from technical capability alone.

A useful empirical architecture is longitudinal. Baseline observations should document task composition, workflow sequence, skill distribution, wages or other income channels, autonomy, responsibility, verification burden, promotion pathways, and access to training. After AI adoption, researchers can observe which tasks are automated, augmented, newly created, or intensified; how error responsibility moves; which skills become more valuable or decay through non-use; and whether workers retain the ability to perform, supervise, or contest the AI-mediated process. Where possible, comparison groups should differ in access, implementation strategy, institutional protections, or complementary training rather than simply in whether AI exists in the environment.

Definition 22.678 (AI labor-transformation panel). *An AI labor-transformation panel is a longitudinal research record that follows changes in task composition, workflow position, output, verification burden, skill use and learning, employment status, income source, bargaining conditions, responsibility, autonomy, dependency, and participation for specified worker or occupational positions across an AI-mediated transition.*

The panel makes several claims testable. Augmentation should produce observable changes in joint performance or task scope rather than merely preserve headcount. Substitution should identify which functions are actually transferred and what replaces the displaced relation. Skill upgrading should appear in later independent or transferable capability, not only in AI-assisted output. Deskilling should be distinguished from simple task relief by evidence that relevant capability erodes or that workers lose practical capacity to verify, maintain, or revise the process.

Labor transformation also has distributive and institutional dimensions. A productivity gain can be captured through wages, profits, lower prices, reduced hours, expanded services, or other channels. The same technological change can therefore

produce different labor consequences under different bargaining, ownership, welfare, or regulatory arrangements. Cross-institutional comparison is particularly valuable because it separates technical possibility from the institutional rules through which that possibility is allocated.

Proposition 22.679 (Labor-transition attribution condition). *A claim that AI transforms labor should identify the affected task or relational mechanism, the organizational pathway through which it changes employment or work, the distribution of complementary gains and burdens, and the temporal horizon over which skill, income, responsibility, and participation effects are evaluated.*

This condition prevents short-run task observations from becoming automatic forecasts of occupational disappearance. It also leaves room for historically novel forms of work or participation whose categories cannot be specified in advance.

22.15.5 Ownership of Productive Intelligence

Ownership research should map the productive-intelligence stack rather than treat “AI ownership” as one binary variable. Economically consequential control can be located in model weights or service rights, compute, proprietary data, distribution platforms, application interfaces, deployment infrastructure, identity and payment systems, evaluation tools, organizational workflows, or the contractual rights governing use. Legal ownership of one layer may confer little effective control if another weakly substitutable layer is decisive. Conversely, a position without formal ownership can exercise substantial control through exclusive access, platform governance, switching costs, or authorization rights.

Definition 22.680 (Effective productive-intelligence control map). *An effective productive-intelligence control map records the legally and practically relevant rights over models, compute, data, platforms, interfaces, deployment infrastructure, evaluation systems, organizational integration, derivative outputs, modification, portability, and access, together with the mechanisms through which each controlled layer conditions productive use by other positions.*

The map invites layer-specific evidence. Researchers can examine concentration in compute supply, model provision, cloud access, data repositories, platform distribution, enterprise integration, or public infrastructure separately. They can then test how these layers interact. Multi-layer concentration can matter more than concentration in any one component if control at several points creates cumulative entry barriers. But vertical integration is not automatically evidence of harmful power. The research design should examine substitutability, performance differences, switching costs, access terms, interoperability, and the consequences of refusal or withdrawal.

Public, cooperative, open, and commons arrangements require the same discipline. Nominal openness should be separated from effective usability. A model can be openly licensed while demanding compute unavailable to many users. Public infrastructure can broaden access while still depending on proprietary components. Distributed ownership can create formal representation without practical governance if participants cannot exercise information, voting, modification, or exit rights. The empirical object is effective control and capability realization.

Proposition 22.681 (Ownership–capability conversion condition). *A claim that ownership of productive intelligence generates capability advantage should identify the controlled layer, the practical right exercised through that layer, the alternatives available*

to other positions, and the mechanism through which control changes access, cost, scale, learning, bargaining, or future productive possibility.

This proposition creates an interface with power research while preserving the distinction between concentration and effective power. It also allows research to identify cases in which concentrated ownership coexists with broad capability diffusion because access is stable and alternatives are strong, as well as cases in which apparently broad access masks dependence on a tightly controlled bottleneck.

22.15.6 Dependency

Dependency becomes analytically important when a position's consequential activity or future alternatives rely on an AI-mediated capability whose terms, continuity, quality, or governance are controlled elsewhere or difficult to reproduce. Ordinary reliance is not sufficient. Most complex production depends on external infrastructures. The research question is whether the reliance materially narrows substitutability, exit, verification, learning, or continuity in ways that alter the dependent position's practical possibility set.

Researchers can measure dependency through interruption and switching analysis. What happens if price changes, access is suspended, a model is updated, an interface disappears, data portability is restricted, or output quality shifts? Can the organization substitute another system? How much adaptation time, data migration, retraining, or workflow redesign is required? Can users continue core operations manually or through alternative infrastructure? Has repeated AI use strengthened independent capability, left it unchanged, or weakened it? These questions convert dependency from rhetoric into an empirically investigable relation.

Definition 22.682 (AI dependency vector). *An AI dependency vector records the degree to which a specified position relies on an AI-mediated configuration across operational continuity, epistemic access, verification, data portability, workflow integration, skill retention, institutional authorization, switching capacity, fallback availability, and the generation of future alternatives.*

The vector permits asymmetric dependencies. A firm can depend operationally on one provider while retaining strong internal verification and switching capacity. A profession can maintain nominal autonomy while becoming epistemically dependent on systems it cannot audit. A public institution can possess fallback procedures but face high costs of transition. Research should therefore avoid reducing dependency to one scalar unless the aggregation rule is independently justified.

Dependency can also be mutually constituted. Providers can depend on users, data suppliers, skilled maintainers, public infrastructure, or regulatory legitimacy. Human-AI collectives can develop reciprocal complementarities without one-sided dependency. Mapping reciprocal dependence can reveal bargaining structure and resilience more accurately than a one-directional account.

Proposition 22.683 (Dependency persistence condition). *A stronger claim of persistent AI dependency requires evidence that reliance is reproduced across time through weak substitutability, accumulated switching costs, erosion or absence of fallback capability, control of complementary infrastructure, learning effects, contractual or institutional constraints, or other identifiable mechanisms that make exit or reconfiguration materially difficult.*

The persistence condition also creates a direct long-horizon research question: whether current convenience gradually becomes future necessity because alternative capabilities are not maintained. Longitudinal evidence is particularly important where dependency is hypothesized to emerge through cumulative organizational redesign or skill externalization.

22.15.7 Human Participation

Human participation cannot be measured adequately by whether a human remains physically or administratively present in an AI-mediated process. A person may remain “in the loop” while having little influence over problem framing, input selection, verification standards, final criteria, institutional redesign, or the capacity to contest the system. Conversely, a highly automated process can coexist with strong human participation if people retain meaningful roles in setting purposes, governing infrastructure, revising institutions, learning, creating alternatives, and deciding where automation should or should not operate.

Research should therefore distinguish several participation functions: contribution to knowledge production; participation in consequential decisions; capacity to shape organizational and institutional rules; participation in care, community, and cultural practices; ability to verify or challenge AI-mediated outputs; and capacity to generate new arrangements when existing systems become inadequate. These functions need not be equally distributed. Their importance varies by domain and by the consequences attached to the AI-mediated process.

Definition 22.684 (Human generative-participation profile). *A human generative-participation profile records the practical opportunities available to affected human positions to frame problems, contribute knowledge, exercise judgment, verify and contest outputs, participate in consequential decisions, alter institutional rules, maintain relevant skills and relations, and generate or organize future alternatives within an AI-mediated economic configuration.*

Empirical work can operationalize these dimensions through decision records, workflow observation, interviews, governance documents, version histories, appeals and override data, training opportunities, organizational authority, community participation, and evidence of actual institutional revision. The profile should also record who is absent. Participation for highly skilled insiders can increase while clients, junior workers, peripheral communities, or affected non-professional groups lose influence. Aggregate statements about “human participation” can therefore conceal redistribution among human positions.

An especially important object is generative foreclosure. Researchers should examine whether an AI-mediated transition removes the capabilities, records, rights, institutions, or relational pathways through which alternatives could later be formulated and implemented. Current service quality can remain high while future revisability declines. Evidence can include loss of independent expertise, disappearance of alternative providers, weakened public archives, reduced institutional capacity to audit systems, or narrowing of routes through which affected persons can organize competing arrangements.

Proposition 22.685 (Participation-effectiveness condition). *A claim that human participation is preserved or expanded under AI should be supported by evidence of practical influence over consequential stages of the process and by retained capacity to learn,*

contest, revise, and generate alternatives, rather than by human presence or formal consultation alone.

The proposition does not require human control of every operation. It requires clarity about which forms of participation are normatively or functionally relevant to the research question and whether those forms remain practically effective.

22.15.8 Generative Coexistence

Generative coexistence is a research object concerning the reproduction and development of capabilities within sustained human–AI relations. It should not be treated as a predetermined desirable endpoint or as a euphemism for keeping humans nominally involved. The empirical question is whether a configuration allows multiple participating positions, especially human persons and human-governed collectives, to maintain or enlarge relevant capacities for learning, contribution, judgment, institution building, care, culture, and future reconfiguration while artificial systems contribute capabilities that would otherwise be costly or unavailable.

Research can begin with complementarity but should not stop there. Short-run complementarity can raise output while producing long-run dependency or skill erosion. A system can expand individual capacity while concentrating collective infrastructure. It can lower barriers for new participants while weakening the organizations that previously maintained shared knowledge. Generative coexistence therefore requires a temporal and distributional research design.

Definition 22.686 (Generative-coexistence profile). *A generative-coexistence research profile records the capabilities contributed by human and artificial positions, the complementarities and substitutions among them, the distribution of gains and burdens, learning and skill trajectories, ownership and dependency relations, contestability, institutional revisability, participation pathways, maintenance conditions, and changes in each relevant position's capacity to generate future alternatives.*

Comparative cases can be especially informative. Two organizations can deploy similar AI systems but differ in training, worker governance, data practices, public accountability, documentation, fallback capacity, or time allocated for learning. If these institutional differences produce different capability trajectories, research can identify the mechanisms supporting or undermining generative coexistence. Similar comparisons can be made across schools, research institutions, public agencies, cooperatives, professional communities, or platform-mediated work.

The profile also accommodates conflict. Coexistence does not imply that every interest can be jointly maximized. A productivity-improving configuration can reduce employment opportunities; a publicly valuable service can impose new surveillance or dependency costs; open access can create sustainability burdens for maintainers. Research should record these conflicts rather than collapse them into a single net-benefit measure. Where aggregation is attempted, the normative premises belong in the justice architecture rather than being hidden inside the empirical indicator.

Proposition 22.687 (Generative-coexistence evidence condition). *A claim of generative coexistence should show that an AI-mediated configuration does more than produce joint output: it should provide evidence concerning the maintenance or expansion of relevant participant capabilities, the revisability of the relation, the distribution of control and dependency, and the preservation of practical pathways for future learning, contestation, and alternative formation.*

This condition permits negative results. Some efficient configurations may fail the stronger generative criterion. Others may initially create dependency but later develop shared infrastructure and stronger human capabilities. The research programme should be able to describe such temporal reversals rather than classify arrangements once and for all.

22.15.9 Long-Horizon Economic Transformation

Long-horizon research integrates the preceding domains without converting uncertainty into prediction. AI-mediated economic transformation can proceed through coupled changes in capability, knowledge, productive abundance, labor, ownership, dependency, participation, institutions, and value formation. These processes operate at different speeds. Model capability can change quickly, organizational routines more slowly, professional education over longer horizons, and legal or cultural institutions through still different temporalities. The relevant object is therefore a family of historically evolving trajectories rather than one forecasted endpoint.

A first research strategy is repeated configuration mapping. At successive intervals, researchers can reconstruct capability profiles, bottlenecks, ownership layers, labor structures, dependency vectors, participation pathways, and institutional rules. This reveals whether an observed transition is stabilizing, reversing, branching, or producing new constraints. A second strategy is cohort analysis. Different generations of workers, students, organizations, or institutions may encounter AI at different stages of skill formation and therefore exhibit different long-run capability trajectories. A third strategy is comparative institutional analysis across jurisdictions or sectors with different access, welfare, labor, education, competition, public-infrastructure, or governance arrangements.

Scenario methods can be useful when treated as structured exploration rather than forecast. A scenario can specify assumptions about capability progress, compute cost, access, ownership, regulation, labor institutions, education, public investment, and human adaptation, then examine the internally consistent consequences of those assumptions. The evidential status of the result remains conditional. As new evidence arrives, assumptions and trajectories should be revised.

Definition 22.688 (Long-horizon AI transformation ledger). A *long-horizon AI transformation ledger* is a time-indexed research record that tracks changes in artificial and human capability, complementary infrastructure, productive bottlenecks, labor organization, ownership and access, dependency, epistemic capacity, participation, institutional revisability, and the distribution of future generative options across specified economic positions.

The ledger supports analysis of path dependence. Early access advantages can compound through data, learning, organizational integration, and capital. Early public investment can create shared capability infrastructure. Temporary labor displacement can become persistent if training and alternative pathways fail to develop, or remain transitional if institutions facilitate new roles. Dependency can deepen through skill externalization or weaken through interoperability and capability diffusion. The long horizon is therefore not merely an extension of short-run trends; it is a domain in which mechanisms themselves can change.

Researchers should also distinguish transformation from closure. A configuration can become highly stable without being irreversible. Institutions can preserve fall-

back capacities, interoperability, public knowledge, educational depth, decentralized experimentation, or governance rights that keep alternative pathways practically available. Conversely, apparently dynamic innovation can occur inside a narrowing architecture if control, standards, and infrastructure become increasingly difficult to contest. Future-option analysis therefore belongs alongside ordinary productivity and growth measures.

Proposition 22.689 (Long-horizon transformation discipline). *A claim about long-horizon AI economic transformation should identify the coupled mechanisms and timescales being followed, distinguish observed trajectory from conditional scenario, preserve uncertainty about institutional and technical change, and evaluate how the transformation alters the distribution and revisability of future productive, epistemic, participatory, and organizational possibilities.*

Proposition 22.689 prevents the research programme from treating a current technical trend as destiny. It also prevents excessive caution from becoming analytically empty. Strong claims can be made when mechanisms, persistence, and trajectory evidence are strong; weaker claims should remain conditional when the future depends on unsettled technical, political, institutional, or cultural developments.

The nine domains developed in this section form one research architecture. Capability measurement establishes what can actually be done under specified conditions. Knowledge-asymmetry analysis examines unequal epistemic functions and their conversion into later capacity. Productive-abundance research identifies relaxed constraints and relocated bottlenecks. Labor research follows tasks, workflows, income, skills, and participation through transition. Ownership research maps effective control across the productive-intelligence stack. Dependency analysis tests switching, fallback, and continuity. Participation research examines practical influence and alternative-generating capacity. Generative-coexistence research studies whether coupled relations reproduce multiple participants' future capabilities. Long-horizon research follows these objects as historically changing trajectories rather than fixed properties.

Proposition 22.690 (AI capability-asymmetry research-programme closure). *Within the GRE research programme, AI-mediated capability asymmetry should be treated as a relational and historically situated research object whose stronger diagnoses depend on evidence about practical realization, multidimensional comparison, persistence, substitutability, complementary infrastructure, ownership and dependency, participation, and effects on future economic possibility; technical performance alone is insufficient to establish the wider economic claim.*

Proposition 22.690 completes the section's empirical architecture. It also creates the bridge to the next stage of Chapter 22. The present section has specified how AI-mediated asymmetries can be studied across general economic relations. Section 514 turns from these cross-cutting research objects to domain studies, asking how GRE research questions change when education, research institutions, development, humanitarian practice, communities, commons, ecology, care, platforms, and public institutions provide the concrete field of inquiry.

22.16 Domain Studies

The role of this section is to convert the domain architecture developed in Chapter 19 into a coordinated programme of domain-specific research. The objective is to specify how GRE research changes when the field of inquiry is education, research institutions, development, humanitarian practice, communities, commons, ecology, care, platforms, or public institutions. These domains share cross-cutting concerns with relational architecture, allocation, heterogeneous value, conversion, circulation, generative return, spacetime, power, justice, exploitation, epistemic economy, and capability asymmetry, yet they do not instantiate those concerns in identical ways. A relation that counts as access in education can differ materially from access to humanitarian assistance or public administration; continuity in care can carry a different analytical weight from continuity in platform participation; ecological regeneration follows constraints that cannot be represented as institutional revision alone. Domain research therefore requires translation, empirical specification, and reciprocal correction between general GRE constructs and the concrete field.

The discussion proceeds through ten domain programmes. Each programme identifies the principal research object, characteristic relational positions, generative processes, recurrent forms of evidence, temporal horizon, and domain-specific failure modes. The method is plural and comparative. Administrative and transaction records, longitudinal observation, interviews, ethnography, institutional histories, network and process data, field measurement, archival materials, participatory inquiry, experiments, natural experiments, comparative case analysis, and formal modelling can all contribute where they fit the object. No single method is presumed to be adequate across domains. The stronger requirement is that the method make the relevant relation, mechanism, and temporal consequence answerable to evidence.

A domain study also has a second epistemic role. It can reveal a remainder that the general framework represents poorly. Educational research may show that capability cannot be inferred from assisted performance. Care research may show that maintenance and dependency are constitutive rather than residual phenomena. Ecological research may expose irreversibility or threshold behavior inadequately represented by ordinary institutional time. Commons research may show that ownership categories miss layered rights of access, contribution, stewardship, and rule revision. Domain findings therefore provide tests of GRE itself.

Definition 22.691 (Domain-research dossier). A *domain-research dossier* is a structured record of the domain boundary, relevant positions, constitutive relations, resources and infrastructures, value forms, constraints, temporal and spatial horizon, applicable GRE constructs, domain-specific standards, evidence sources, methods, comparison units, unresolved remainders, and conditions under which the initial analytical translation should be revised.

Definition 22.691 treats domain specification as part of research design rather than a descriptive preface. A study of a school, laboratory, refugee-support system, neighborhood, irrigation commons, care network, platform ecosystem, watershed, or public agency should state which boundary is analytically consequential and which external relations remain relevant. Boundaries can also change during inquiry. A school study can become inseparable from household care or digital infrastructure; a commons study can require analysis of state law and ecological flows; a platform study

Table 22.16: Principal domain-study programmes in GRE

Domain	Primary research object	Principal research burden
Education	Learning relations, infrastructures, capability formation, and educational return	Distinguish immediate assisted performance from durable or regenerable learning capability
Research institutions	Funding, inquiry relations, epistemic infrastructure, preservation, criticism, and institutional capacity	Trace how institutions reproduce question formation, verification, memory, openness, and future inquiry
Development	Long-horizon transformation of situated capabilities, institutions, infrastructures, and dependencies	Connect resource and programme inputs to locally maintainable capability and institutional trajectories
Humanitarian practice	Urgent assistance under disruption, displacement, uncertainty, and constrained time	Study present protection together with access, decision standing, continuity, transition, and dependency effects
Communities	Membership, trust, reciprocity, local circulation, collective memory, and relational capacity	Identify how collective relations are reproduced, revised, and distributed among heterogeneous members
Commons	Shared-resource access, contribution, stewardship, monitoring, and rule revision	Separate formal ownership from effective governance and measure resource plus governance reproduction
Ecology	Ecological-economic configurations, flows, biophysical constraints, stewardship, and regeneration	Integrate institutional evidence with material and ecological dynamics, thresholds, and intergenerational incidence
Care	Care relations, dependency, continuity, maintenance, recognition, and capability support	Observe relational quality and maintenance without reducing care to discrete output or recipient productivity
Platforms	Mediation, visibility, data, gatekeeping, algorithmic coordination, and dependency	Reconstruct how technical and governance layers redistribute access, control, learning, and future alternatives
Public institutions	Mandates, administrative access, public capacity, infrastructure, trust, and accountability	Connect formal public authority to usable provision, institutional learning, continuity, and revisable public capacity

can become partly a public-infrastructure study when access to essential activity depends on the platform.

Proposition 22.692 (Domain-translation validity condition). *A domain-specific GRE claim is stronger when the study identifies the concrete positions and mechanisms to which a general construct is being translated, demonstrates that the translated construct has observable or reconstructible consequences in the domain, records domain-specific constraints and standards, and remains open to revising the translation when the domain exhibits a persistent analytical remainder.*

Proposition 22.692 prevents recurring terminology from being mistaken for recurring structure. It also gives negative and corrective findings a legitimate place in the programme. A study can conclude that a GRE construct has low explanatory value in a specified domain, that a different unit of analysis is required, or that the relevant relation belongs partly to a neighboring legal, ethical, ecological, educational, or political framework.

Table 22.16 summarizes the ten programmes developed below.

22.16.1 Education

Education is a domain in which present output and future capacity are especially easy to confuse. Examination scores, assignment completion, credential acquisition, attendance, course completion, and AI-assisted performance can provide useful observations, yet the GRE research object extends to the later capacity to understand, inquire, verify, transfer, judge, collaborate, and enter relevant communities of practice. Domain research should therefore connect educational events to capability trajectories rather than infer learning from immediate performance alone.

A first research stream concerns educational relations. Studies can compare lecture, tutorial, mentoring, peer collaboration, apprenticeship, project work, laboratory practice, online interaction, and AI-assisted learning by reconstructing who supplies explanation, feedback, correction, recognition, challenge, and opportunities for independent practice. The relevant evidence includes classroom observation, interaction records, learner work over time, interviews, concept inventories, transfer tasks, error correction, later performance under reduced support, and participation in subsequent learning settings. Research can then ask which relations generate durable capability and for whom.

A second stream concerns educational infrastructure. Buildings, devices, connectivity, libraries, language support, accessible materials, teacher time, administrative continuity, assessment systems, family support, transport, and digital platforms condition whether a nominal educational opportunity becomes usable. Infrastructure should be studied longitudinally because maintenance failure can produce delayed effects. A school can receive new devices while lacking technical support; an online course can widen nominal access while increasing dependence on language, bandwidth, or self-regulation; a scholarship can remove tuition cost while leaving housing or care constraints unchanged.

A third stream concerns assistance-to-capability conversion. This is especially important under AI-mediated learning. Researchers can vary or observe the degree of external assistance and then test whether learners retain capacity when prompts, hints, model access, or instructor intervention are reduced. They can examine whether assistance improves question formation and verification, or whether it enables successful output without corresponding understanding. The object is a trajectory of capability conversion rather than a binary judgment about whether assistance is beneficial.

Definition 22.693 (Educational capability panel). An *educational capability panel* follows specified learners or learning positions across instructional relations, infrastructures, assistance conditions, assessment events, independent performance, transfer contexts, and later participation in order to identify how an educational arrangement changes durable or regenerable capacities for understanding, inquiry, judgment, verification, action, and further learning.

Educational return can also be collective. Graduates can become mentors, researchers, teachers, civic participants, maintainers of professional standards, or contributors to shared knowledge. Institutions can develop curriculum memory, teacher capacity, accessible infrastructure, and communities of practice that benefit later cohorts. Research on generative educational return should therefore include both learner-level and institutional-level outcomes, while preserving uncertainty about which later effects can credibly be attributed to the educational configuration.

Proposition 22.694 (Educational generativity evidence condition). *A claim of stronger educational generativity should provide evidence that an educational arrangement expands or preserves later learning and participation capacities beyond immediate supported performance, and should identify the relational and infrastructural mechanisms through which those capacities are reproduced across time or cohorts.*

22.16.2 Research Institutions

Research institutions make epistemic generation observable as an organized economic process. Universities, laboratories, institutes, archives, journals, funders, professional associations, data repositories, computing infrastructures, and research communities allocate resources and attention while also shaping which questions can be pursued, which claims can be criticized, which traces are preserved, and which researchers can acquire the capacity to continue inquiry. Output counts capture only part of this process.

A domain programme should therefore follow the complete research-generative chain. Funding decisions condition time, equipment, staffing, and topic selection. Recruitment and mentoring affect entry into communities of inquiry. Laboratory and computational infrastructure determine which operations are feasible. Documentation and preservation affect reproducibility and historical memory. Peer criticism and review influence correction. Openness arrangements determine whether others can inspect and extend work. Career systems influence risk taking, collaboration, maintenance, and question choice. AI systems increasingly enter literature search, analysis, coding, drafting, simulation, and evaluation, creating new capability and verification relations.

Longitudinal institutional comparison is particularly valuable. Two research organizations with similar budgets can differ in mentoring density, technical support, data stewardship, preservation, staff continuity, freedom to pursue uncertain questions, or the capacity to learn from failed projects. Bibliometric output alone can miss these differences. Mixed evidence can combine publication and citation records with grant histories, laboratory notebooks, repository use, replication records, staff trajectories, mentoring networks, interviews, infrastructure audits, and records of negative or abandoned inquiry.

Definition 22.695 (Research-institution generativity audit). *A research-institution generativity audit examines how funding, personnel, scientific relations, infrastructure, criticism, openness, preservation, epistemic technologies, and governance jointly affect an institution's capacity to formulate consequential questions, conduct and verify inquiry, preserve reconstructible traces, regenerate research capability, and enable later revision or extension.*

The audit should make maintenance visible. Repository curation, equipment calibration, software maintenance, administrative support, peer review, data documentation, mentoring, and preservation can appear secondary when evaluation focuses on novel outputs. Yet these activities often reproduce the conditions under which novelty remains possible. A research system can increase publication volume while degrading verification or institutional memory; it can expand access while overloading the people who maintain shared infrastructure; it can become technically sophisticated while narrowing the diversity of questions that can receive sustained attention.

Research also needs a correction mechanism for prestige and visibility. Highly visible outputs can be generated by a small number of institutions while wider research capacity becomes more concentrated or fragile. Conversely, distributed infrastructures can generate large collective capacity without producing equally visible local outputs. The relevant economic object includes the distribution of question-forming, verifying, preserving, and mobilizing capability across the research system.

Proposition 22.696 (Research-institution capacity condition). *A claim that a research institution or research system is more generative should examine output together with question formation, verification, preservation, capability regeneration, entry pathways, infrastructural maintenance, and the continued possibility of criticism and revision.*

22.16.3 Development

Development research concerns transformations whose relevant horizon commonly exceeds the life of a single intervention. Resources can finance infrastructure, training, services, organizational reform, credit, technology, or public capacity, yet the research question is how these inputs interact with historically formed institutions, local relations, ecological conditions, political constraints, knowledge systems, and existing capabilities. GRE domain research therefore treats development as a trajectory of situated capacity formation and reconfiguration.

The first burden is baseline reconstruction. A programme can appear to create an institution that in fact depends on pre-existing informal coordination, unpaid labor, local knowledge, public infrastructure, or ecological resources. Conversely, an intervention can be judged ineffective when its principal contribution is to preserve a fragile relation or capability during a period of disruption. Baselines should therefore include relational and institutional conditions rather than only income, output, or service indicators.

The second burden is conversion. The same transferred resource can generate different outcomes because maintenance skills, authority, complementary infrastructure, language, legal status, trust, ecological conditions, or access to markets differ. Research should identify these conversion conditions and follow them after initial implementation. A water system, digital service, training programme, agricultural technology, or local enterprise can produce immediate gains while later becoming unusable if repair capacity, financing, governance, or local decision standing is absent.

The third burden is dependency and exit. External support can appropriately persist where long-term redistribution or shared provision is intended. The research problem is therefore not to assume that development should culminate in complete local self-sufficiency. It is to identify which dependencies are supportive and governable, which expose local positions to fragile external control, and whether affected institutions retain practical capacity to revise the arrangement.

Definition 22.697 (Development trajectory dossier). *A development trajectory dossier records the pre-intervention relational and institutional configuration, resource and knowledge inputs, conversion conditions, participation and decision rights, capability changes, infrastructure and maintenance requirements, dependency relations, ecological constraints, distributional incidence, and the persistence or revision of these effects after the initiating programme or funding phase.*

Comparative development research should use cases that expose mechanism varia-

tion rather than merely rank outcomes. Similar interventions across different institutional contexts can reveal how local governance or maintenance changes conversion. Different interventions within similar contexts can reveal which resources are genuinely binding. Historical comparison can show how earlier programmes created path dependence that conditions present options.

Proposition 22.698 (Developmental attribution condition). *A claim that a development intervention generated durable capacity should identify the conversion and maintenance mechanisms through which programme inputs became locally usable capabilities or institutions, distinguish those effects from pre-existing and external enabling conditions, and test whether the resulting capacities persist, adapt, or remain governable after the initial intervention phase.*

22.16.4 Humanitarian Practice

Humanitarian practice shares several mechanisms with development while operating under different temporal and ethical constraints. Acute conflict, disaster, displacement, epidemic, infrastructure collapse, or sudden deprivation can make immediate protection the dominant objective. Time pressure, incomplete information, damaged institutions, mobility, security risk, and uncertain duration constrain participation and research design. A generative research programme must therefore preserve the legitimacy of urgent assistance while studying how emergency arrangements affect later continuity, capability, dependency, and transition.

A first research stream concerns access under disruption. Formal availability of shelter, food, cash, healthcare, documentation, transport, or protection does not establish practical access. Researchers can trace registration requirements, identity systems, language, mobility, security, information channels, queueing, digital connectivity, family composition, disability access, legal status, and local intermediaries. Process data and ethnographic observation are especially valuable because aggregate delivery totals can conceal exclusion at particular steps.

A second stream concerns decision standing. Intensive participatory procedures may be infeasible during acute emergency, but affected persons still generate information about needs, safety, social relations, informal institutions, and unintended effects. Research can examine which mechanisms allow information and contestation to enter operational decisions, how representatives are selected, whether complaints generate revision, and whose voices remain systematically absent.

A third stream concerns transition. Temporary systems can persist for years. Parallel service structures can protect life while weakening or bypassing local institutions; alternatively, they can preserve capacity during institutional collapse and later support reconstruction. Cash transfers can strengthen local circulation under some conditions and encounter supply or inflation constraints under others. Humanitarian research should therefore follow how emergency arrangements couple to host communities, public institutions, markets, care networks, and later development or recovery processes.

Definition 22.699 (Humanitarian response-transition dossier). *A humanitarian response-transition dossier records the emergency conditions, affected positions, protection objective, access pathway, allocation and delivery mechanism, local institutional interfaces, decision-standing arrangements, dependency and continuity risks, distributional effects, and the pathways through which an emergency configu-*

ration is maintained, revised, transferred, integrated, or withdrawn over time.

Research ethics are part of the domain design. Evidence collection can impose burden, reveal sensitive information, or alter access to assistance. The informational value of a measurement should therefore be assessed against participant risk and operational cost. Existing administrative and operational traces can sometimes answer questions with less burden, while participatory inquiry may be indispensable where official categories omit consequential experience.

Proposition 22.700 (Humanitarian continuity condition). *A stronger evaluation of humanitarian practice should examine immediate protection together with practical access, exclusion, local institutional interaction, decision standing, continuity of essential relations, and the transition consequences through which emergency assistance changes later capability and dependency.*

22.16.5 Communities

Community research focuses on relations of membership, recognition, reciprocity, trust, shared history, informal coordination, collective memory, and local participation. A community can exist without governing a clearly bounded common resource, and membership itself can be plural, contested, intermittent, or externally imposed. The unit of analysis should therefore be specified empirically rather than inferred from residence, identity category, or organizational membership.

The first task is to map differentiated standing. Participants can have unequal access to information, voice, protection, recognition, contribution opportunities, informal authority, or exit. Long-term members, newcomers, temporary residents, marginalized groups, volunteers, local organizations, and external partners can occupy different positions. Social-network data can reveal interaction patterns, yet interpretation requires attention to relation type and meaning. Frequent contact does not necessarily indicate trust, influence, or support; sparse contact can still connect a participant to critical resources.

A second task is to study relational maintenance. Meetings, rituals, mutual aid, conflict mediation, local media, shared spaces, volunteer work, informal care, documentation, and intergenerational transmission can reproduce the relations through which collective action remains possible. These activities often produce few easily priced outputs. Research can combine time-use data, participation histories, event records, interviews, network change, institutional archives, and observation to identify which maintenance practices matter during ordinary periods and during shocks.

A third task concerns trust and correction. Trust can reduce coordination cost, but robust community capacity also depends on ways to address breach, exclusion, succession, and disagreement. Research should therefore examine verification, dispute resolution, representation, leadership transition, record keeping, and the ability to revise local rules.

Definition 22.701 (Community relational-capacity study). *A community relational-capacity study reconstructs membership and standing, recurrent relations, trust and verification, maintenance practices, collective memory, local circulation, conflict and repair, external interfaces, and changes in the community's practical capacity to coordinate, learn, include participants, and generate future collective action.*

Community generativity should not be equated with cohesion. Highly cohesive re-

lations can exclude outsiders, suppress disagreement, or concentrate authority. More fragmented communities can retain strong bridging relations and effective institutions. The research burden is to identify which relational configuration supports the specified collective capacities and how costs and benefits are distributed.

Proposition 22.702 (Community-generativity identification condition). *A claim of stronger community generativity should show how identifiable relations and maintenance practices reproduce collective capacity, while separately examining exclusion, unequal standing, conflict, external dependency, and the practical possibility of rule or membership revision.*

22.16.6 Commons

Commons research shifts the primary object from community relation to the governance and reproduction of a shared resource or infrastructure. The resource can be ecological, physical, informational, cultural, digital, or institutional. Access may be open, bounded, tiered, licensed, customary, or conditional on contribution. Participants can hold different rights to access, use, contribute, exclude, manage, monitor, transfer, or revise rules. Formal ownership therefore provides only one part of the empirical architecture.

The research programme should follow both resource condition and governance capacity. A fishery, forest, irrigation system, community facility, open-source project, shared dataset, knowledge repository, or cultural archive can remain available in the short run while maintenance or governance capacity deteriorates. Conversely, temporary restriction can support long-run regeneration. Resource metrics and institutional metrics should therefore be observed together.

Contribution is another central object. Commons can rely on labor, money, expertise, moderation, monitoring, documentation, repair, ecological restraint, or conflict resolution. These contributions are often heterogeneous and difficult to compare. Researchers should record how contribution becomes visible, how obligations are allocated, which work is under-recognized, and whether burden concentration affects continued participation. A generative-exploitation question can arise when a shared resource is broadly appropriated while maintenance remains concentrated on actors whose capacity is being depleted, but that stronger diagnosis requires the mechanism established in Section 22.13.

Definition 22.703 (Commons stewardship research record). *A commons stewardship research record documents the shared resource, participant positions, bundles of access and governance rights, contribution and maintenance practices, monitoring, sanction and dispute procedures, resource condition, external pressures, institutional memory, rule-revision mechanisms, and the distribution of stewardship capability across time.*

Comparative studies can examine how governance responds to resource growth, scarcity, technological change, new membership, commercialization, environmental stress, or external regulation. The same institutional feature can have different effects at different scales. Informal monitoring may work in a small group and fail after rapid expansion; formal procedures can increase accountability while raising entry costs; open access can accelerate innovation while creating maintenance overload.

Proposition 22.704 (Commons reproduction condition). *A claim that a commons is sustainably generative should provide evidence concerning both the reproduction or*

regeneration of the shared resource and the reproduction of the stewardship, knowledge, participation, monitoring, and rule-revision capacities required to govern that resource under changing conditions.

22.16.7 Ecology

Ecological domain research requires GRE to couple institutional and economic analysis to biophysical processes that do not conform to administrative boundaries or human decision cycles. Material and energy flows, hydrological systems, soils, atmospheric processes, species interactions, waste accumulation, ecosystem succession, and regeneration rates can condition economic possibilities across long and uneven timescales. Evidence must therefore integrate social and ecological observation rather than translate ecological relations into economic proxies alone.

A first research stream traces ecological flow pathways. Material flow accounts, remote sensing, field sampling, life-cycle data, production records, land-use histories, infrastructure maps, and local ecological knowledge can be combined to follow extraction, transformation, transport, use, recirculation, dissipation, assimilation, and accumulation. The research object includes who controls or depends on each stage and which effects are displaced spatially or temporally.

A second stream studies biophysical constraints and thresholds. Economic adaptation can substitute among technologies or institutions, yet some processes have limited regeneration rates, critical dependencies, irreversibilities, or threshold-sensitive transitions. A domain dossier should state which ecological claims are directly measured, which are model-based, and where uncertainty remains. Institutional flexibility cannot be assumed to compensate for ecological loss when the relevant material or living process cannot be restored on the decision horizon.

A third stream concerns stewardship capability. Monitoring, ecological knowledge, legal authority, financing, maintenance, public participation, indigenous and local knowledge, institutional memory, and cross-jurisdictional coordination can jointly determine whether an ecological system can be cared for and adapted. Stewardship research should examine both ecological condition and the institutions capable of responding to change.

Definition 22.705 (Ecological–economic research dossier). *An ecological–economic research dossier combines ecological-flow evidence, biophysical constraint and threshold information, affected human and non-human relations, institutional and ownership arrangements, stewardship capacities, value conflicts, spatial and temporal displacement, uncertainty, and intergenerational consequences for a specified ecological–economic configuration.*

Intergenerational analysis is especially important because current action can transmit both conditions and constrained option sets. Later participants can inherit infrastructure, knowledge, restored ecosystems, pollution, depleted stocks, invasive species, altered climate conditions, financial liabilities, or institutions capable of repair. Research should therefore distinguish current ecological performance from the inheritance structure being created.

Proposition 22.706 (Ecological-domain adequacy condition). *A GRE study of an ecological domain is adequate only to the extent that its economic and institutional account remains consistent with the relevant material and ecological dynamics, including regeneration rates, thresholds, irreversibilities, spatial coupling, uncertainty, and the*

temporal distribution of consequences.

22.16.8 Care

Care is a domain in which relation, maintenance, dependency, time, and embodied presence can be constitutive of the economic object. Childcare, elder care, disability support, healthcare, household care, community support, mentoring, and other caring practices can involve discrete tasks, yet their value can also depend on continuity, responsiveness, trust, attentiveness, familiarity, and the capacity to notice changing needs. Research designs centered only on completed tasks or units of service can therefore omit consequential relational dimensions.

A first stream concerns care configuration. Researchers can map caregivers, recipients, households, employers, public institutions, providers, technologies, financing, eligibility rules, scheduling systems, and informal support. Time-use data are important but should be combined with information about intensity, unpredictability, emotional and cognitive load, coordination burden, travel, waiting, and responsibility. Two equal hours of recorded care can correspond to different burdens and different relational effects.

A second stream concerns continuity and substitution. Some care tasks can be standardized or technologically assisted; other functions may depend on knowledge accumulated within a relationship. Researchers should identify which elements are substitutable, which require transition, and what happens when continuity is broken. Staff turnover, fragmented scheduling, platform-mediated matching, institutional relocation, or AI-mediated support can alter both efficiency and relational knowledge.

A third stream concerns capability on both sides of the relation. Care can support another person's capacity for health, participation, learning, mobility, security, or valued life. It can also expand or erode caregiver capability depending on time, recognition, income, support, authority, and respite. The recipient should not be evaluated by whether care increases economic productivity. The relevant outcomes are domain-specific capabilities, security, participation, continuity, and dignity, with normative standards stated explicitly rather than hidden inside productivity measures.

Definition 22.707 (Care-reproduction ledger). *A care-reproduction ledger records the caring positions and dependencies, time and coordination demands, continuity and relational knowledge, material and institutional supports, compensation and recognition, technological mediation, recipient capability effects, caregiver capability effects, maintenance requirements, and the conditions under which the care relation can continue, transfer, or be revised without avoidable deterioration.*

Care research also reveals system-level externalization. A hospital, school, firm, or welfare programme can appear efficient while relying on unpaid family care or exhausted professional caregivers. Policy changes can shift care burdens across households, genders, generations, public agencies, markets, and communities. Incidence analysis should therefore follow where care work and responsibility move rather than recording only formal expenditure.

Proposition 22.708 (Care-generativity evidence condition). *A claim that a care arrangement is generatively stronger should examine whether it sustains the recipient's relevant capabilities and continuity while also reproducing the material, temporal, relational, and institutional capacities required for caregivers and care systems to continue and revise care without systematic depletion.*

22.16.9 Platforms

Platform research studies mediated economic configurations in which technical interfaces and governance rules jointly condition interaction. Marketplaces, labor platforms, app ecosystems, social and creator digital platforms, payment systems, software platforms, educational platforms, and other digital intermediaries can organize visibility, matching, ranking, identity, transaction, reputation, data capture, technical access, and dispute resolution. Their economic effects arise from the coupling of these mechanisms rather than from network size alone.

The first research burden is to reconstruct mediation. Researchers should record which interactions require the platform, what alternatives exist, how participants enter, which rules determine visibility or matching, what data are generated, who can access or recombine those data, and how rule changes are communicated and contested. Interface experiments, ranking audits, transaction records, developer documentation, contractual histories, user interviews, and longitudinal account data can make different layers observable.

The second burden is to distinguish growth from participant generativity. A platform can increase transactions or users while complementors become more dependent on platform-specific reputation, tools, or interfaces. Conversely, a strongly integrated platform can expand participant capability by lowering coordination and trust costs. Research should examine entry pathways, learning, portability, switching, interoperability, complementary investment, and the distribution of rule-making capacity.

The third burden concerns algorithmic coordination. Recommendation, pricing, moderation, matching, risk scoring, and automated enforcement can change participant behavior and opportunity without participants being able to observe the operative rule. Research should document models and objectives where possible, but black-box settings can still be investigated through outcome patterns, controlled accounts, policy changes, appeals, interviews, and comparative observation. The evidential claim should match the level of access.

Definition 22.709 (Platform mediation audit). A *platform mediation audit* records participant positions, entry and visibility mechanisms, transaction or interaction rules, data capture and use, algorithmic coordination, gatekeeping, payment and reputation systems, governance and appeal pathways, interoperability, switching and portability, dependencies, and changes in participant capability and future alternatives.

Platform research should also follow external interfaces. Private platforms can rely on public identity, transport, payment, communication, education, and legal infrastructure, while public institutions can themselves become dependent on private cloud, data, identity, or AI services. These couplings can move a research question across the boundary between platform governance and public infrastructure.

Proposition 22.710 (Platform-generativity research condition). A *claim about platform generativity* should connect mediation and governance mechanisms to participant-level changes in access, capability, learning, dependency, portability, contestability, and the practical capacity to create or pursue alternatives beyond the current platform relation.

22.16.10 Public Institutions

Public-institution research examines how mandates become practical public capacity. Laws, budgets, formal eligibility, and organizational charts specify important parts of a public configuration, yet usable provision depends on administrative pathways, professional judgment, records, infrastructure, coordination, trust, accountability, and continuity. Research should therefore connect formal authority to the relations through which public purposes are interpreted and enacted.

A first stream concerns administrative access. Researchers can reconstruct the sequence through which a person or organization learns of a provision, establishes eligibility, supplies documentation, communicates with officials, receives a decision, accesses a service, corrects an error, and appeals where necessary. Process mining, administrative data, waiting-time records, user journeys, interviews, accessibility audits, and case files can reveal where formal entitlement fails to become practical access.

A second stream concerns public institutional capacity. Staffing, professional knowledge, fiscal resources, procurement, data systems, infrastructure maintenance, inter-agency coordination, legal authority, institutional memory, and discretion can jointly determine whether a mandate is executable. Capacity should be studied across ordinary operations and shocks. Temporary emergency performance can rely on extraordinary labor that is difficult to sustain; apparent routine efficiency can depend on deferred maintenance or depleted staff capability.

A third stream concerns learning and trust. Public institutions need mechanisms to observe changing conditions, preserve records, receive feedback, correct classification errors, revise procedures, and retain legitimacy when using delegated authority. Trust should be studied relationally rather than through approval scores alone. Reliability, procedural integrity, bounded authority, competence, explanation, correction, and responsiveness can support different forms of warranted reliance.

Definition 22.711 (Public-institution generativity audit). A *public-institution generativity audit* examines the relation among mandate, administrative access, resources, professional and organizational capability, public infrastructure, information and records, service continuity, accountability, trust, institutional learning, and the capacity to revise public action as needs and conditions change.

Public generativity includes maintenance as well as innovation. Keeping a registry accurate, preserving a transit system, sustaining a public-health laboratory, maintaining legal aid, retaining experienced staff, or ensuring benefit continuity can preserve the conditions for later collective action. Research should therefore avoid treating institutional novelty as the principal sign of adaptation. Sometimes the generative achievement is reliable continuity under changing conditions.

The domain also creates an interface with democratic, legal, and political standards whose justification exceeds GRE. Economic research can examine access, capability, dependence, resource incidence, institutional learning, and long-horizon option effects. Questions of legitimate authority, rights, constitutional constraints, and democratic representation require explicit engagement with neighboring normative domains. A domain dossier should record these interfaces rather than absorbing them into an economic indicator.

Proposition 22.712 (Public-institution research condition). A *claim of stronger public institutional generativity* should show how formal mandate is converted into usable

and accountable public capacity, and should examine whether access pathways, infrastructures, professional capabilities, records, trust relations, learning mechanisms, and revision procedures can be maintained across changing conditions and successive users.

The ten programmes demonstrate why domain research is a distinct stage of the GRE research programme. General constructs create a shared vocabulary for comparison, while domains determine which relations are constitutive, which evidence is credible, which constraints are binding, which normative standards must be imported or separately justified, and which temporal horizon is appropriate. Education foregrounds learning conversion; research institutions expose epistemic reproduction; development foregrounds situated capability trajectories; humanitarian practice makes urgency and transition central; communities foreground membership and relational maintenance; commons foreground stewardship and rule revision; ecology introduces biophysical coupling and thresholds; care foregrounds dependency and continuity; platforms foreground technical mediation and gatekeeping; public institutions foreground mandate, access, capacity, and accountability.

Proposition 22.713 (Domain-study research-programme closure). *Within GRE, domain studies should operate as bidirectional tests between general economic constructs and situated empirical fields: the framework guides the identification of relations, mechanisms, value processes, constraints, and temporal consequences, while domain evidence can localize, revise, supplement, or reject an attempted translation where the concrete field exhibits materially different structures or standards.*

Proposition 22.713 completes the domain-study layer without turning the ten domains into an exhaustive taxonomy. Other fields can be added when their objects and evidence are specified with comparable discipline. The next stage of Chapter 22 shifts from substantive research objects and domains to methodological programmes. Section 515 develops the formal research programme, asking which parts of GRE can be represented mathematically or computationally, what such representations make testable, and where formalization should remain explicitly partial.

22.17 Formal Research Programme

The role of this section is to specify a formal research programme for GRE without converting formalization into a substitute for empirical, historical, or interpretive inquiry. The objective is to identify model families that can represent recurrent GRE problems—changing relational structures, uncertain transitions, higher-order interaction, distributed fields, compositional transformations, cross-model translation, relational distance, event order, heterogeneous agents, history dependence, and stronger history-based constructions—while making the assumptions and evidential bridges of each representation explicit. The section therefore treats formal models as research instruments whose adequacy depends on the target question, data-generating process, scale, temporal horizon, and inferential burden.

The discussion proceeds through fourteen model families and a model-comparison programme. The families overlap. A temporal hypergraph can also be dynamical; an agent-based model can generate a network; a field model can be stochastic; an operator representation can act on a history-bearing state; a 2-complex can carry history weights; and a transition kernel can appear inside several larger architectures. The purpose of the classification is consequently functional rather than ontological.

It identifies characteristic representational capacities and characteristic failure risks so that researchers can choose, combine, simplify, or reject models for stated reasons.

A formal GRE project should preserve a visible separation among the empirical target, its formal representation, the mathematical consequences of that representation, and the return from model results to claims about the target. This separation is especially important where a formalism has strong internal elegance. Mathematical consistency can establish what follows under specified assumptions; it does not by itself establish that the assumptions describe an economic configuration. Conversely, imperfect empirical identification does not make formal work useless. A model can expose hidden assumptions, derive conditional implications, identify impossible combinations, generate discriminating observations, or show that apparently verbal claims are mutually inconsistent.

Definition 22.714 (Formal-research specification). *A formal-research specification records the target economic configuration, research question, modeled objects and relations, state or history representation, admissible transformations, parameters and boundary conditions, observables or empirical correspondences, data or interpretive inputs, inferential outputs, validation strategy, competing representations, scope of application, and conditions for model revision or rejection.*

Definition 22.714 makes the empirical bridge part of the formal project itself. The same mathematical object can receive different economic interpretations, and the same economic process can admit several mathematical representations. A graph edge can represent exchange, authority, trust, communication, ownership, or another typed relation; a field variable can represent a measured density, a latent potential, a modeled constraint, or an analytically constructed quantity. The research specification should state which interpretation is intended and what evidence supports it.

Proposition 22.715 (Formal proportionality condition). *A formal GRE model is proportionate to its research task when each increase in representational complexity preserves or reveals a distinction that is material to the target claim, the required assumptions are stated, the model has an interpretable relation to evidence or comparison, and a simpler representation would lose analytically consequential structure.*

Proposition 22.715 gives model complexity an evidential burden. A 2-complex should not replace an event sequence merely because it is mathematically richer; an operator algebra should not replace ordinary transition notation where order-sensitive composition is absent; a field should not be introduced where the relevant processes are discrete and institutionally bounded. Richer formalisms become justified when the research object contains the corresponding structure.

Table 22.17 summarizes the principal model families and their characteristic research burdens.

22.17.1 Dynamical Models

Dynamical models are appropriate when the research question concerns the evolution of an economic configuration rather than a comparison of static states. GRE adds a particular emphasis on dynamics that alter the conditions of later dynamics. A model can therefore track changes in resources, capacities, value configurations, institutional rules, relational structures, constraints, or access while also allowing selected parts of the transition rule to change over time.

Table 22.17: Principal model families in the GRE formal research programme

Model family	Structures made explicit	Principal research burden
Dynamical	State change, feedback, regime change, coevolution	Show that modeled states, rules, and timescales correspond to the target process
Stochastic	Uncertainty, transition distributions, latent branching	Distinguish aleatory representation from ignorance, misspecification, and measurement error
Network / hyper-graph	Typed relations, topology, higher-order interaction	Justify nodes, relation types, boundaries, and the empirical meaning of topology
Field	Distributed quantities, locality, gradients, coupling	Specify the domain, field meaning, boundary conditions, and evidence for locality or continuity
Algebraic	Composition, invariants, equivalence, transformation rules	Demonstrate that the chosen operations preserve the economically relevant structure
Category-theoretic	Typed objects, morphisms, compositional interfaces, translations	Provide concrete semantic mappings and avoid purely diagrammatic redescriptions
Geometric	Distance, constraint surfaces, neighborhoods, paths	Justify the metric or geometry and distinguish analytical distance from physical space
Spacetime	Joint event order, location, accessibility, trajectories	Preserve empirical event identification and avoid importing physical ontology
Agent-based	Heterogeneity, interaction rules, adaptation, emergence	Calibrate micro-rules and validate both process and macro-level consequences
Operator-algebraic	Order-sensitive transformations, observables, composition	Identify the operational meaning of operators and the evidence for noncommutative or algebraic structure
Partial-order/2-complex	Precedence, branching, concurrency, higher-order histories	Reconstruct event order and higher-order incidence rather than imposing them
History-weight/kernel	Path dependence, memory, delayed transition structure	Link history dependence and transition weights to observed or reconstructible sequences
Amplitude-like	Non-additive history combination under stronger assumptions	State the additional assumptions and empirical reason ordinary probabilities or weights are inadequate

A minimal discrete-time representation can distinguish an economic state x_t from a relational structure R_t . Where both coevolve, one possible model family is stated in Equations 22.3 and 22.4.

$$x_{t+1} = F_t(x_t, R_t; \theta_t), \quad (22.3)$$

$$R_{t+1} = G_t(R_t, x_t; \eta_t). \quad (22.4)$$

In Equations 22.3–22.4, x_t denotes the modeled state variables at time t , R_t denotes the modeled relational configuration, F_t and G_t are transition maps, and θ_t and η_t collect model-specific parameters or constraints. The time subscripts on the maps and parameters permit nonautonomous dynamics. They should be used only where the research design has a reason to represent changing rules or environments. A fixed-rule model remains adequate where rule change is not material to the target claim.

Dynamical GRE research should distinguish several kinds of change. Movement within a stable regime differs from a transition between regimes; parameter change differs from topological change; endogenous adaptation differs from an external shock; and a changing state differs from a change in the categories used to describe the state. The last distinction is especially important historically. If a legal or institutional transformation changes who counts as a worker, firm, asset, claimant, or eligible participant, a model with a fixed state vocabulary can become inadequate even if its numerical dynamics remain well behaved.

Definition 22.716 (Dynamical GRE study). A *dynamical GRE study* specifies the evolving state, relational configuration, transition rules, timescale, boundary conditions, candidate feedbacks, observable trajectories, and the empirical or historical evidence

used to distinguish state change from structural or rule change.

Dynamical models become especially useful for generative return, fast-slow coupling, path dependence, power persistence, institutional learning, ecological regeneration, and AI-mediated capability trajectories. Their validation can combine trajectory fit, held-out temporal prediction, qualitative mechanism evidence, regime comparison, sensitivity analysis, and examination of failure cases. A model that reproduces one observed trajectory can remain weakly identified if many alternative rules generate the same pattern.

Proposition 22.717 (Dynamic-structure identification condition). *A claim that an observed economic transformation is generated by a specified dynamical structure requires evidence that discriminates the proposed transition and feedback mechanisms from materially different dynamics capable of producing the same observed trajectory.*

22.17.2 Stochastic Models

Stochastic models become relevant when realized trajectories branch, transitions are only probabilistically specified, or the research design needs to represent uncertainty explicitly. They can model event arrival, adoption, failure, learning, migration among institutional states, innovation, shocks, search, matching, or other processes in which a deterministic transition is not justified. The stochastic representation should nevertheless specify what the probability means in the research context.

A transition probability can represent repeated variation in an ensemble, uncertainty conditional on observed information, an estimated behavioral propensity, or a modeling device for unresolved microstructure. These interpretations are not interchangeable. A study should also distinguish transition uncertainty from measurement error, missing variables, structural uncertainty, and uncertainty about the model family itself. Encoding all uncertainty as one probability distribution can conceal rather than clarify the epistemic problem.

For a modeled state s_t and information set I_t , a local stochastic transition can be represented by a kernel $K_t(s' | s_t, I_t)$. The information set can include current relations, constraints, and selected history when the Markov assumption is not defensible. The research burden is to justify which information is included and which conditional independences are being imposed.

Definition 22.718 (Stochastic transition dossier). *A stochastic transition dossier records the modeled state space, event or transition of interest, probability interpretation, conditioning information, estimation or calibration procedure, uncertainty decomposition, observed transition evidence, structural alternatives, and tests of whether memoryless or stationary assumptions are adequate.*

Stochastic models can also clarify rare but consequential pathways. A low-probability transition can dominate long-run risk where its consequences are large or irreversible. Conversely, a frequently observed transition can matter little to generative capacity. GRE research should therefore avoid equating probability with value, importance, justice, or desirability.

Proposition 22.719 (Stochastic-interpretation condition). *A probabilistic GRE result should be interpreted only at the level supported by its probability model: estimated transition likelihood, uncertainty conditional on specified information, or simulated frequency does not by itself establish causal mechanism, normative significance, or onto-*

logical randomness.

22.17.3 Network and Hypergraph Models

Network and hypergraph models make relational architecture explicit. Pairwise graphs are useful where relations can be represented between two positions without material loss. Directed, weighted, signed, temporal, multiplex, or multilayer networks can preserve further distinctions. Hypergraphs and related higher-order structures become relevant when the interaction itself requires three or more participants, resources, institutions, or roles jointly.

The main research difficulty precedes calculation. Researchers must decide what constitutes a node, which relation types are represented, whether absence of an observed tie indicates nonrelation or missing observation, how boundaries are drawn, and how relation meaning changes through time. Measures such as centrality, clustering, modularity, reachability, brokerage, or higher-order overlap acquire economic meaning only through this specification.

GRE network research is especially suited to circulation, allocation pathways, epistemic exchange, platform mediation, supply and care relations, ownership and control, institutional coordination, commons governance, and power dependencies. Hypergraph models can represent research teams, household arrangements, multi-party contracts, committees, joint production, common-pool governance, or other relations whose structure is lost when decomposed into pairwise ties.

Definition 22.720 (Relational-model audit). *A relational-model audit records node or position construction, relation types and direction, higher-order incidence where relevant, boundary rules, observation process, temporal resolution, missingness, weighting, layer structure, derived network quantities, and the economic interpretation assigned to those quantities.*

Network change should also be distinguished from state change on a fixed network. An institution can alter access rules without changing the set of organizations; a platform can change recommendation rules while user connections appear stable; a crisis can create new dependencies without changing formal ownership. Adaptive or temporal network models become warranted when such relational change is part of the target mechanism.

Proposition 22.721 (Relational-form adequacy condition). *A network or hypergraph representation is adequate to a GRE claim only when the relation arity, type, direction, temporality, and boundary required by that claim are preserved at sufficient resolution for the proposed mechanism or comparison.*

22.17.4 Field Models

Field models are useful when economically relevant quantities or constraints vary across a domain and local conditions interact with neighboring conditions. The domain can be geographic, infrastructural, relational, institutional, technological, or another modeled space. A field can represent density, accessibility, cost, risk, information intensity, capability, potential, congestion, ecological condition, or another quantity whose local variation and coupling are analytically important.

The word *field* should remain formally specific. A descriptive statement that an

organization operates in a “field of power” does not by itself warrant a mathematical field model. Formal field research requires a domain, a variable or operator associated with locations or regions in that domain, a rule for coupling or propagation, and boundary or interface conditions. Continuity is also an assumption rather than a default. Discrete institutional positions can require lattice, graph-field, or piecewise representations instead of a smooth domain.

Field models can be productive for spatial inequality, infrastructure accessibility, environmental externalities, diffusion, congestion, capability landscapes, information propagation, and distributed power effects. They can also couple to network models where transport or influence follows discrete relational channels embedded in a wider spatial or institutional environment.

Definition 22.722 (GRE field-model specification). A *GRE field-model specification* states the modeled domain, field quantity or operator, empirical interpretation, locality or coupling rule, boundary and interface conditions, temporal dynamics where present, measurement or calibration procedure, and the conditions under which discrete or nonlocal structure requires a different representation.

A field representation can make gradients visible. Yet a gradient is only analytically meaningful if the underlying quantity and distance relation are meaningful. A modeled decline in accessibility across geographic distance can be empirically interpretable; a gradient in an abstract “power field” requires a more explicit construction of positions, effects, and distance before it supports substantive claims.

Proposition 22.723 (Field-evidence condition). A *GRE field model* supports a *target-level claim* only where the modeled domain, local quantity, coupling structure, and boundary conditions have an interpretable relation to the observed or reconstructed economic configuration; mathematical smoothness alone supplies no evidence for that relation.

22.17.5 Algebraic Models

Algebraic models are useful when the research question concerns composition, transformation rules, invariants, equivalence, symmetry, or the effect of repeatedly applying operations. GRE problems involving value conversion, institutional operations, allocation procedures, capability transformation, rule composition, and equivalence among relational structures can all have algebraic aspects.

An algebraic representation begins by specifying the objects on which operations act and the properties the operations satisfy. Associativity, commutativity, inverses, identities, closure, partiality, and idempotence should not be assumed for convenience when they have substantive implications. Conversion operations can be noninvertible; institutional operations can be defined only on some states; order can matter; and repeated application can change the space of admissible later operations.

The programme should therefore include partial algebras, semigroups, group actions, lattices, ordered algebraic structures, and other constructions where they fit the target rather than privileging groups or vector spaces. Invariants can be especially useful for comparison: if a transformation preserves a quantity or structural property, researchers can ask whether that preservation has an empirical counterpart and whether observed violations indicate model failure or regime change.

Definition 22.724 (Algebraic transformation model). An *algebraic transformation*

model specifies a class of economic objects or states, admissible operations on those objects, domains of definition, composition rules, identities or invariants where present, and the empirical interpretation of both operations and preserved or changed structure.

Algebraic abstraction can compress repeated reasoning. It can also erase economically important history if two configurations are treated as equivalent merely because they share an invariant. GRE research should therefore record which distinctions are intentionally quotiented out and which histories remain relevant to later possibility.

One promising minimal research template studies irreversible loss of distinctions without placing an order, metric, arithmetic, or vector structure on the state carrier. Let a bare carrier S be acted on by a semigroup M , and let an equivalence relation $\sim$ specify distinctions that the modeled system is required to preserve under admissible mechanisms. For a mechanism m , a derived collapse relation can record pairs $x \not\sim y$ whose images become equivalent after m acts. Under the additional requirement that the action preserve $\sim$, any such collapse remains collapsed after subsequent mechanisms in the same semigroup action. The construction is potentially useful for studying irreversible loss of discriminatory capacity, classification distinctions, institutional separations, or option distinctions without requiring a scalar measure of loss.

The template is deliberately model-relative. The equivalence relation carries substantive analytical or normative content and is not supplied by semigroup theory itself. Choosing what the system is required to distinguish can therefore be the most consequential modeling decision. Nor should the derived collapse relation replace the book's more general vocabulary of difference: it is one formalization of lost discrimination under a specified congruence, not a definition of difference across GR or GRE. The absence of inverses also has only local model meaning. A reversible action can preserve every distinction tracked by this template while the empirical process still has historically relevant timing, cost, or path structure not represented by the chosen carrier.

Proposition 22.725 (Algebraic-quotient caution). *An algebraic equivalence or quotient is substantively defensible only when the distinctions it removes are irrelevant to the target claim across the stated domain; historical, distributional, relational, or normative differences that alter later possibilities should not be eliminated merely for formal convenience.*

22.17.6 Category-Theoretic Models

Category-theoretic models become useful when composition and typed translation among structures are central. They can represent objects and morphisms, compositional processes, functors between representational domains, natural transformations between translations, and higher-order relations among transformations. For GRE, potential applications include value-conversion interfaces, institutional process composition, model translation, multi-level relational architectures, and interfaces between economic and neighboring domain models.

The principal risk is redescription without gain. Drawing a commutative diagram around concepts does not establish a category-theoretic result. A useful categorical model should identify what the objects are, what counts as a morphism, which compositions are admissible, what identities mean, and which empirical or conceptual

problem becomes clearer because the typed structure is explicit.

Category theory can be particularly helpful where several model layers should remain distinct. A micro-level agent process, a network-level relational representation, and an institution-level state can be connected by mappings without assuming that one level is reducible to another. Functorial structure can then state which compositions or invariants are intended to be preserved across representations. Failure of preservation can itself be informative.

Definition 22.726 (Categorical research mapping). A *categorical research mapping* specifies the source and target categories, the empirical or analytical meaning of their objects and morphisms, the structure a proposed functor preserves, and the observations or formal checks by which preservation, failure of preservation, or partial translation can be assessed.

Partial, enriched, double, or higher-categorical constructions may become relevant where transformations are only partially defined, relations carry additional structure, or morphisms themselves enter structured relations. Such extensions should be introduced only when the simpler categorical architecture loses a distinction material to the research question.

Proposition 22.727 (Categorical-semantic condition). A *category-theoretic GRE model* contributes substantive research content when its typed compositional structure constrains possible translations, exposes a nontrivial preservation or incompatibility result, or organizes empirically interpretable processes that would otherwise be conflated.

22.17.7 Geometric Models

Geometric models are appropriate when distance, neighborhoods, feasible regions, trajectories, boundaries, or deformations carry analytical meaning. The geometry can be Euclidean, non-Euclidean, discrete, information-geometric, graph-derived, or otherwise constructed. GRE applications can include relational distance, accessibility landscapes, capability spaces, constraint surfaces, policy trajectories, institutional deformation, or comparison among configurations.

The central research burden is metric construction. A numerical distance is not neutral. Geographic distance, travel time, transaction cost, communication latency, institutional similarity, legal accessibility, semantic difference, or learned embedding distance can produce different neighborhoods. A model should state what the distance encodes, how it is estimated, and whether the triangle inequality, symmetry, or other metric properties are substantively appropriate.

Geometry can also be topological rather than metric. Connectivity, holes, boundaries, reachability regions, and changes in connected components can matter even where no defensible continuous metric exists. This distinction is useful for access research: two positions can be close in one attribute space while disconnected by legal or institutional constraints.

Definition 22.728 (Geometric adequacy record). A *geometric adequacy record* states the modeled space, coordinate or feature construction, distance or topology, empirical interpretation, boundary and constraint structure, relevant invariants, sensitivity to alternative geometries, and the substantive claim for which geometric representation is required.

Geometric language should remain distinct from evaluative language. A central position is not necessarily desirable; a short path is not necessarily just; a stable basin is not necessarily beneficial. Normative interpretation requires the separate justice and value architecture developed elsewhere in the book.

Proposition 22.729 (Geometric-interpretation condition). *A geometric property can support an economic interpretation only through an explicit mapping from geometric structure to the target relation or constraint; geometric centrality, curvature, distance, basin structure, or connectivity does not carry an intrinsic economic or normative meaning.*

22.17.8 Spacetime Models

Spacetime models combine temporal order with spatial, relational, or accessibility structure. Their role in GRE is to represent processes in which when and where an event occurs jointly condition later reachability, interpretation, or generative consequence. The relevant “space” need not be physical geography. It can include institutional location, network position, jurisdictional domain, technological layer, or another relation-bearing coordinate system.

A GRE spacetime study should begin from empirically identified events or process intervals. It can then represent precedence, coexistence, accessibility, delay, and trajectory. Different positions can inhabit heterogeneous presents: information, infrastructure, legal status, technological capability, or institutional response can reach them at different times. A single calendar date therefore need not imply a common effective state.

Spacetime models are particularly useful for delayed generation, path dependence, diffusion, cascading failure, infrastructure deployment, historical sequencing, policy timing, and cross-scale dynamics. They can also preserve branching futures without assuming that one realized history was inevitable.

Definition 22.730 (Economic spacetime model). *An economic spacetime model represents identified events or states together with temporal ordering, modeled location or relational position, accessibility relations, relevant delays, trajectories, and boundary conditions in order to study how spatiotemporal organization changes later economic possibility.*

The physical analogy has limits. GRE does not infer Lorentzian structure, relativistic invariance, physical causality, or a fundamental spacetime ontology from the usefulness of joint temporal and relational representation. Those structures can be imported only where a clearly specified formal analogy performs work and its assumptions are independently stated.

Proposition 22.731 (Spacetime proportionality condition). *A spacetime representation is warranted when temporal order and modeled position jointly affect the target mechanism or reachable alternatives, and when a simpler chronology or static relational map would lose that joint dependence.*

22.17.9 Agent-Based Models

Agent-based models provide a computational laboratory for heterogeneous positions, local interaction rules, adaptation, bounded information, institutional constraints,

and emergent macro-patterns. They are especially useful where aggregation would erase heterogeneity or where analytical solutions are unavailable. In GRE, agents need not correspond only to individual humans. Organizations, households, institutional roles, artificial systems, or other operational units can be modeled when the research question justifies that level of agency.

The micro-rule burden is substantial. A simulation can generate complex macro-patterns from arbitrary local rules. Researchers should therefore connect decision rules, interaction structures, learning mechanisms, resource constraints, and institutional conditions to empirical or historically interpretable evidence. Calibration to one aggregate pattern is insufficient when alternative micro-rules produce similar outputs.

Agent-based research can examine allocation cascades, cooperation and commons governance, institutional emergence, labor and AI interaction, platform dynamics, innovation diffusion, care networks, ecological adaptation, and intervention scenarios. It can also explore counterfactual institutional rules that are difficult or unethical to test directly. Counterfactual usefulness nevertheless depends on whether the model preserves the mechanism relevant to the proposed intervention.

Definition 22.732 (Agent-based GRE protocol). *An agent-based GRE protocol records agent or position types, state variables, interaction topology, decision and learning rules, institutional constraints, initialization, stochastic elements, parameter sources, output measures, calibration targets, sensitivity analysis, validation evidence, and the conditions under which emergent patterns are interpreted as target-system evidence.*

Validation should operate at several levels. Micro-level behavior can be compared with observed decisions or process evidence; meso-level relations can be compared with network or institutional patterns; macro-level trajectories can be compared with aggregate data; and historical sequence can be compared with observed regime development. Failure at one level should not be hidden by fit at another.

Proposition 22.733 (Agent-based multilevel validation condition). *An agent-based GRE model supports a mechanism claim more strongly when its local rules, intermediate relational structures, and macro-level consequences each receive independent empirical or interpretive support, rather than when only the final aggregate pattern is reproduced.*

22.17.10 Model Comparison

Model comparison is a substantive part of the formal programme because several representations can fit the same economic configuration while preserving different structures. Comparison should therefore extend beyond goodness of fit. The programme should evaluate representational adequacy, assumption burden, empirical identifiability, explanatory discrimination, predictive performance where relevant, sensitivity, interpretability, computational tractability, transportability, and historical stability.

Nested models can sometimes be compared through standard statistical criteria. Many GRE model families will not be nested and may not even share the same output space. A historical event graph and an agent-based simulation can illuminate the same case without being directly rankable by one scalar criterion. In such settings, comparison should identify which questions each model can answer, which observations discriminate among them, and which conclusions remain representation-

dependent.

A useful strategy is model triangulation. If a result survives materially different representations whose assumptions fail in different ways, confidence can increase. Divergence is equally informative. If a network model suggests increasing integration while a historical process model shows growing institutional exclusion, the disagreement can reveal a scale or measurement problem rather than a need to force one model to win.

Definition 22.734 (GRE model-comparison matrix). A *GRE model-comparison matrix* records, for each candidate model, the target question, represented structures, assumptions, empirical mappings, free parameters, identification strategy, fit or predictive criteria where applicable, mechanism implications, omitted structures, computational costs, interpretability, sensitivity, transport conditions, and distinctive failure modes.

Model comparison should also include the null option of using no elaborate formal model. A qualitative process reconstruction or descriptive statistical analysis can be superior when the formal alternatives require assumptions that overwhelm the available evidence.

Proposition 22.735 (Plural model-comparison condition). *No single model-selection criterion is sufficient across the GRE formal programme; model choice should be relative to the target inference, and incompatible model families should be compared through the structures they preserve, the evidence they explain or predict, and the failures that would discriminate among them.*

22.17.11 Operator-Algebraic Models

Operator-algebraic models become relevant when transformations act on a state, configuration, or observable space and the composition or order of those transformations matters. They offer a disciplined language for intervention sequences, institutional operations, information updates, capability transformations, and power mechanisms that change later admissible states. The operator should have an economic interpretation before its algebraic properties receive substantive meaning.

Let S denote a model-specific state space and let T_a and T_b denote two admissible transformations on that space. If applying T_a before T_b produces a different result from the reverse order, the composition is order-sensitive. This can be expressed through $T_b T_a \neq T_a T_b$ where both compositions are defined. The inequality is analytically useful only if the modeled operations correspond to empirically meaningful sequences. Training before delegation can differ from delegation before training; legal recognition before investment can differ from investment before recognition; platform rule changes can alter the effects of later participation incentives.

Operator research can extend from finite transformation matrices to linear or non-linear operators, semigroups, operator-valued fields, and C^* - or W^* -algebraic structures under stronger assumptions. Such extensions can clarify observables, spectra, invariant subspaces, repeated dynamics, or open-system composition. GRE does not infer quantum mechanics from the use of operator algebras; these mathematical structures have applications beyond quantum theory.

Definition 22.736 (Economic-operator model). An *economic-operator model* specifies a state or observable space, economically interpreted transformations acting on that

space, their domains and codomains, admissible compositions, order dependence, invariants or fixed structures where relevant, and the evidence connecting operator action to observed or reconstructible change.

Power research can use operator language cautiously where one position repeatedly changes the accessible states or transition tendencies of another. The formalization should preserve the distinction between a transformation operator and the substantive power relation. The latter still requires the asymmetry, dependence, mechanism, alternatives, persistence, and contestability established in Section 22.11.

Proposition 22.737 (Operator-order research condition). *An operator-algebraic representation adds distinctive value when the admissibility, outcome, or later generative consequence of economic transformations depends materially on their composition, ordering, invariant structure, or action on observables in ways that simpler transition notation does not preserve.*

22.17.12 Partial-Order and Cellular-Complex Models

Partial-order models are appropriate where some events have supported precedence relations while other events are concurrent, incomparable, or only weakly ordered. They avoid imposing a total chronology that the evidence does not warrant. A partially ordered set can represent legal prerequisites, production dependencies, research sequences, institutional approvals, infrastructure installation, or historical processes with branching and concurrency.

A 2-complex adds higher-order incidence to an event-and-relation architecture. Vertices can represent events or configurations, edges can represent admissible transitions or precedence relations, and faces can represent higher-order process relations among sequences or coupled transformations. This structure can encode alternative histories, compositional constraints, or the relation among paths without treating the economic world as literally made of two-dimensional cells. It remains the economical default where these structures and attached cell data preserve the distinctions required by the research question.

A higher CW-complex supplies a further option when higher-order attachment should remain native to the carrier. The 2-complex can be retained as a 2-skeleton while cells of higher dimension record question-relative compositional closure, incidence among composite structures, refinement, or generative genealogy. The motivation is structural preservation rather than raw information capacity. An enriched 2-complex can encode extensive higher-order data; the comparative question is whether flattening that data into labels or auxiliary structures makes the topology on which the inference depends opaque.

The research burden is reconstruction. Event boundaries should be supported by records, observations, testimony, process evidence, or a defensible coding rule. Precedence should not be inferred merely from narrative convenience. Faces or higher cells should correspond to an analytical relation that lower-order links and attachments fail to preserve transparently. If the empirical material supports only a sequence, the richer complex should remain unused. If a 2-complex with explicit enrichment preserves the relevant higher-order relations at lower assumption and reconstruction cost, additional cellular dimension remains unnecessary.

Definition 22.738 (History-complex construction protocol). *A history-complex construction protocol specifies event boundaries, partial-order relations, admissible tran-*

sitions, cellular dimension and attachment rules where relevant, higher-order incidence, boundary configurations, empirical provenance for each encoded relation, unresolved ordering, and the analytical question that requires the selected complex rather than a simpler event graph or lower-dimensional carrier.

Partial-order and cellular-complex models can interface naturally with generative spacetime research, process tracing, transition kernels, and history weights. They are especially useful where the order and composition of events affect later accessibility while several paths remain possible. The carrier should remain analytically separate from the rule system that generates or transforms it. A cellular complex records one represented structure or history; a generative grammar, rewrite system, transition rule, or other transformation law specifies which structural changes are admissible. Inferring the latter from the former requires additional evidence or assumptions.

Proposition 22.739 (Higher-order history condition). *A 2-complex representation is warranted when empirically or theoretically relevant relations among paths, processes, or coupled transformations cannot be preserved by an event set with pairwise precedence relations alone. A higher CW-complex is warranted only when target-relevant higher-order incidence, attachment, compositional closure, refinement, or generative genealogy would otherwise be externalized in a way that materially weakens the intended inference.*

Proposition 22.740 (Carrier–grammar separation). *A cellular representation of a generated structure does not by itself identify the generative grammar or transformation law that produced it. Claims about admissible structural generation should therefore specify the rule system separately and state the evidence, derivation, or assumptions connecting that rule system to observed or reconstructed cellular histories.*

22.17.13 History-Weight and Transition-Kernel Models

History-weight and transition-kernel models formalize a central GRE concern: the probability, accessibility, or consequence of a next transition can depend on the path by which the present configuration was reached. A current state can therefore be insufficient. The model must carry selected historical information, a memory variable, or an explicit history.

Let $h_t = (s_0, \dots, s_t)$ denote a modeled history ending in state s_t . A history-dependent transition kernel can then be represented as in Equation 22.5.

$$K_t(s_{t+1} \mid h_t, c_t), \quad (22.5)$$

Here c_t denotes additional modeled conditions at time t . Equation 22.5 does not require the full past to matter. Researchers can test whether a finite memory, sufficient statistic, regime label, cumulative exposure, institutional age, or another compressed history retains the distinctions required by the target claim. A memoryless kernel becomes a special case where the relevant past is adequately summarized by the current state and conditions.

History weights address a related but different task. Instead of specifying only the next transition, a model can assign a nonnegative weight to an admissible history according to evidence, mechanism, cost, likelihood, or another declared criterion. The weight should not be called a probability unless it is normalized and given a probabilistic interpretation.

Definition 22.741 (History-sensitive transition model). A *history-sensitive transition model* specifies admissible histories, the historical information retained for later transitions, the transition kernel or history-weight rule, the empirical basis for memory dependence, and tests comparing the history-sensitive model with a simpler state-dependent alternative.

Applications include institutional hysteresis, trust formation, cumulative disadvantage, skill formation, ecological degradation, technological lock-in, generative return, power persistence, and repeated human–AI coupling. In each case, a history effect should be empirically distinguished from an omitted contemporaneous variable where possible.

Proposition 22.742 (History-dependence identification condition). A *formal claim of history dependence is strengthened when two configurations that are similar on the modeled current state exhibit systematically different transition tendencies or consequences in ways explained by reconstructible differences in their prior trajectories.*

22.17.14 Amplitude-Like Models under Stronger Assumptions

Amplitude-like models occupy a deliberately restricted place in the GRE formal programme. They are relevant only where the research question requires a history-combination rule richer than ordinary additive probabilities or nonnegative weights. One possible motivation arises when several admissible histories contribute jointly to a modeled outcome and the composition rule permits cancellation, phase-sensitive combination, or another non-additive relation that has a defensible interpretation in the target model.

The term *amplitude-like* is used to preserve distance from a physical claim. GRE does not infer quantum behavior, wave functions, Planck-scale structure, or physical superposition in economic systems. A complex- or signed-valued history weight can be mathematically useful without carrying quantum ontology. The researcher must state why a conventional probability model, stochastic process, signed measure, path weight, or deterministic multi-path model is insufficient.

Suppose $\mathcal{H}(B)$ denotes a specified set of admissible histories connecting a boundary condition to an outcome class B , and $A(h)$ is a model-specific amplitude-like weight assigned to history h . A generic history-combination quantity can be represented as in Equation 22.6.

$$\mathcal{A}(B) = \sum_{h \in \mathcal{H}(B)} A(h). \quad (22.6)$$

Equation 22.6 becomes empirically meaningful only after the history set, weight construction, composition rule, observables, and relation between $\mathcal{A}(B)$ and measured quantities are specified. If the model subsequently maps $\mathcal{A}(B)$ into a probability or another observable, that mapping constitutes an additional assumption and should be tested independently where possible.

Spin-foam-inspired constructions can be treated as one special research direction within this stronger-assumption class. A 2-complex can supply the combinatorial history architecture, while labels and local weights encode model-specific states or transitions. The physical spin-foam formalism should not be imported wholesale. Representation labels, amplitudes, gauge structure, and boundary Hilbert spaces require

separate justification if used; otherwise the economic construction remains an analogy or adapted mathematical architecture.

Definition 22.743 (Amplitude-like GRE model). *An amplitude-like GRE model specifies an admissible history space, boundary conditions, a signed, complex, or otherwise non-probabilistic history-weight structure, a composition rule, an observable map, and an empirical or theoretical reason that a simpler nonnegative weight or probability representation does not preserve the target phenomenon.*

The validation burden is correspondingly high. A successful fit obtained through flexible amplitude assignments provides weak evidence if an ordinary stochastic model performs equally well. Stronger support would require discriminating observations, structural constraints, or derived consequences that depend specifically on the non-additive history-combination rule.

Proposition 22.744 (Stronger-assumption burden). *An amplitude-like GRE model should be preferred over probabilistic, weighted-history, or deterministic alternatives only when the additional history-combination structure is required by the target question, produces empirically or formally discriminating consequences, and remains interpretable without treating mathematical analogy as ontological evidence.*

The formal research programme therefore ends with an asymmetry of burden. Richer mathematics can enlarge the questions GRE is able to formulate, but each added structure also increases the responsibility to identify its empirical meaning, assumptions, alternatives, and failure conditions. Dynamical, stochastic, relational, field, algebraic, categorical, geometric, spacetime, agent-based, operator, history-complex, kernel, and amplitude-like approaches should consequently develop as partially interoperable research languages rather than stages in a hierarchy culminating in one preferred formalism.

Proposition 22.745 (Formal pluralism and cumulative correction). *The GRE formal research programme is cumulative when model families expose hidden assumptions, generate discriminating observations, preserve empirical and historical mappings, and allow results to survive, weaken, localize, or fail across representations. Formal unification remains optional.*

22.18 Historical and Interpretive Research Programme

The role of this section is to specify the historical and interpretive programme required for GRE claims whose objects cannot be adequately reconstructed from present-state measurements, formal models, or decontextualized records alone. The objective is to make temporal formation, changing categories, institutional memory, situated meaning, archival survival, legal interpretation, and later re-evaluation into explicit research objects with their own evidential burdens. The programme complements the formal programme of Section 22.17. Formal representations can make dependence, composition, and possible dynamics explicit; historical and interpretive inquiry asks how the represented objects came to exist, how their meanings and boundaries changed, which alternatives were available at particular times, how actors understood the situations in which they acted, and how the evidence available to later researchers was itself produced and preserved.

The discussion proceeds through historical reconstruction, comparative history, conceptual history, institutional history, genealogy, archival inquiry, ethnography,

legal and institutional interpretation, and re-epistemization. These approaches overlap but are not interchangeable. A historical reconstruction can establish a sequence without recovering the meanings participants assigned to it. A genealogy can reconstruct the formation of a category without supplying a continuous institutional history. Ethnography can reveal enacted practice while remaining unable to establish the historical prevalence of that practice. Legal interpretation can identify rights and obligations that ordinary behavioral data do not disclose. Archival inquiry can reconstruct both past relations and the conditions through which traces of those relations survived. The programme therefore preserves methodological plurality while requiring explicit interfaces among methods.

Historical and interpretive research in GRE should also preserve a distinction between the past configuration and the later epistemic configuration from which it is studied. Researchers often know outcomes, institutional consequences, or conceptual distinctions that historical actors could not know. Later knowledge can make earlier evidence newly intelligible, but it can also produce retrospective determinism or category projection. The programme consequently records what was observable, thinkable, institutionally available, or contested at the relevant historical time separately from what became visible only later.

Definition 22.746 (Historical-interpretive research dossier). *A historical-interpretive research dossier records the research object, temporal and institutional boundaries, relevant positions and relations, historical categories, later analytical categories, evidential traces and their provenance, missing or inaccessible materials, actor interpretations, competing reconstructions, legal or institutional conditions, translation problems, as-of epistemic limits, later knowledge, and conditions under which the reconstruction should be revised.*

Definition 22.746 treats provenance, category change, interpretive plurality, and later re-evaluation as parts of the research design rather than as supplementary commentary. A dossier can be compact for a narrowly bounded institutional episode or extensive for a long-run transformation. Its purpose is not to force every study to use the same materials. It is to make visible which historical and interpretive dependencies support the claim.

Proposition 22.747 (Historical-interpretive warrant condition). *A historical or interpretive GRE claim is strengthened when the temporal sequence, evidential provenance, changing category system, relevant institutional conditions, situated interpretations, alternative reconstructions, and the distinction between contemporaneous and later knowledge are explicit enough for the claim to be challenged and revised.*

Table 22.18 summarizes the principal research domains and their characteristic burdens.

22.18.1 Historical Reconstruction

Historical reconstruction studies how an economic configuration formed, persisted, changed, or disappeared through temporally ordered relations and events. Its distinctive contribution to GRE is the reconstruction of generative conditions. A present arrangement can contain resources, institutions, dependencies, categories, and power relations that were produced through sequences whose effects survive after the initiating events have ended. Cross-sectional observation can describe the present configuration while leaving these formative relations invisible.

Table 22.18: Principal domains in the GRE historical and interpretive research programme

Research domain	Primary object	Principal research burden
Historical reconstruction	Sequences, turning points, alternatives, path dependence	Distinguish supported sequence from retrospective inevitability
Comparative history	Similar and divergent trajectories across cases	Establish comparability without erasing historically specific relations
Conceptual history	Changing meanings and uses of economic categories	Separate historical vocabularies from later analytical translation
Institutional history	Formation, persistence, layering, and transformation of institutions	Reconstruct formal change together with practical enactment and memory
Genealogy	Formation of categories, norms, subject positions, and problem fields	Recover contingency and effects without inventing a single hidden origin
Archival inquiry	Surviving traces and infrastructures of historical visibility	Analyze provenance, survival, silence, arrangement, access, and missingness
Ethnography	Situated practices, tacit coordination, and lived relations	Make researcher position, access, interpretation, and scope explicit
Legal/institutional interpretation	Rules, rights, obligations, procedures, and authoritative meanings	Distinguish formal validity, interpretation, implementation, and effect
Re-epistemization	Later reconstruction of earlier evidence and claims	Preserve the earlier epistemic state while incorporating later knowledge

The research object should therefore include more than chronology. A historical reconstruction identifies relevant events, their ordering, the relations connecting them, the alternatives that remained available at each stage, and the mechanisms through which earlier events altered later possibility. The importance of an event lies partly in what it changed about subsequent access, capability, institutional admissibility, interpretation, or constraint. An apparently small administrative decision can become historically consequential if it creates a category, infrastructure, precedent, dependency, or path that later decisions inherit.

Definition 22.748 (Temporal reconstruction protocol). A *temporal reconstruction protocol* specifies the historical interval, event criteria, source chronology, relevant actors and positions, contemporaneous categories, candidate mechanisms, turning points, feasible alternatives where reconstructible, continuity and rupture claims, unresolved gaps, and the evidence used to connect earlier events with later conditions.

The protocol should distinguish at least four claims that are often conflated. First, event *A* occurred before event *B*. Second, *A* altered a condition relevant to *B*. Third, the alteration contributed causally to *B*. Fourth, the later outcome was inevitable once *A* occurred. Evidence supporting the first or second claim does not automatically establish the third, and even strong support for the third does not establish the fourth. GRE's emphasis on path dependence should therefore increase rather than reduce attention to unrealized alternatives and contingency.

Historical reconstruction also requires category sensitivity. A category such as labor, property, welfare, household, platform, research output, or public service can change its legal, administrative, cultural, and economic meaning across the period being studied. Applying a later stable variable retrospectively can generate an artificial continuity. Researchers should record category bridges where terms or classifications change and should leave mappings partial where equivalence cannot be defended.

Proposition 22.749 (Non-retrospective reconstruction condition). A *GRE historical reconstruction* should explain how later configurations became possible through earlier

relations while preserving the difference between reconstructed causal contribution and retrospective necessity.

22.18.2 Comparative History

Comparative history examines similarities and differences among historical trajectories in order to distinguish locally specific sequences from more portable mechanisms or structural relations. The unit of comparison can be an institution, city, sector, legal order, community, technology, policy regime, organization, market, or another historically bounded configuration. Comparison is especially useful when superficially similar outcomes arose through different paths or when similar starting conditions generated divergent outcomes.

GRE comparison should avoid treating cases as interchangeable containers of variables. Historical cases possess different inherited relations, category systems, institutional memories, external dependencies, and temporal rhythms. A comparison is therefore strongest when it specifies which dimensions are being compared and which remain intentionally non-equivalent. The same nominal policy can operate differently where prior trust, legal authority, infrastructure, social hierarchy, ecological conditions, or organizational memory differ.

Definition 22.750 (Comparative-history matrix). A *comparative-history matrix* records for each case the historical boundary, initial relational configuration, relevant categories, institutional inheritance, sequence of focal events, external conditions, turning points, candidate mechanisms, observed outcomes, missing evidence, and dimensions of comparability and non-comparability.

The matrix supports several forms of inference. Researchers can compare convergent trajectories produced by different mechanisms, divergent trajectories under similar interventions, repeated institutional sequences, or contrasts between cases in which a proposed GRE mechanism is present and absent. Negative comparison is equally important. A mechanism that appears central in one case can fail to travel because the supporting relation does not exist elsewhere.

Comparative history can therefore test claims of domain portability. If a proposed relation between generative return and institutional durability appears repeatedly across cases with different surface features, confidence in the relation can increase. If the relation disappears when a particular legal or cultural condition changes, the claim may need localization rather than abandonment. Comparison should make that scope change explicit.

Proposition 22.751 (Historically bounded comparison). *Comparative historical evidence supports a GRE mechanism most strongly when similarity and difference are reconstructed at the level of relations and sequences relevant to the mechanism rather than inferred from nominal similarity among cases.*

22.18.3 Conceptual History

Conceptual history studies the changing meanings, uses, contrasts, and institutional locations of concepts through which economic life becomes intelligible. GRE requires such work because many of its research objects are accessed through historically changing vocabularies. Value, productivity, dependency, care, exploitation, innovation, public interest, capability, intelligence, welfare, ownership, and work are not

merely labels attached to invariant objects. Their meanings can shift as institutions, technologies, legal orders, normative expectations, and forms of expertise change.

A conceptual history should reconstruct terms in relation to the vocabularies that surrounded them at the relevant time. Meaning can depend on contrast. A concept of productive labor can change when domestic work, care, digital participation, or machine-generated output enters the field of debate. A concept of ownership can change when the relevant object becomes data, model access, licensing rights, platform control, or distributed infrastructure. The research task is not simply to locate the earliest use of a word but to reconstruct changes in the relations that make a concept intelligible and practically consequential.

Definition 22.752 (Concept-history version record). *A concept-history version record documents a concept's historically situated meanings, neighboring and opposing terms, institutional sites of use, relevant actors, practical functions, contested interpretations, translation across periods or languages, later analytical uses, and unresolved discontinuities among versions.*

The version record prevents two symmetrical errors. One is presentism, in which contemporary meanings are projected backward. The other is antiquarian isolation, in which historical concepts are treated as incapable of informing present analysis. GRE can use historical concepts generatively when the translation is explicit. A historical distinction can reveal a relation neglected by current vocabulary, while a contemporary concept can support a new question about older evidence. Neither direction establishes identity of meaning.

Conceptual history also matters for measurement. A longitudinal dataset can appear stable while the social meaning of its categories changes. If the classification of employment, household, disability, research output, or firm status changes, observed trends can combine real transformation with category transformation. Historical interpretation should therefore accompany quantitative series when classification stability is uncertain.

Proposition 22.753 (Conceptual translation condition). *A GRE concept can be used across historical periods only to the extent that the translation records which relations and distinctions are preserved, transformed, newly introduced, or lost.*

22.18.4 Institutional History

Institutional history reconstructs how rules, organizations, procedures, authority relations, infrastructures, and patterned expectations accumulate through time. Institutions rarely change as single coherent objects. New rules can layer onto older procedures; informal practices can persist beneath formal reform; organizational memory can outlast personnel; inherited infrastructure can constrain later policy; and emergency arrangements can become normalized. GRE therefore treats institutional persistence and change as relational and temporally layered.

Institutional history should distinguish formal enactment from practical realization. A legal reform can alter formal rights without changing access when implementation resources, administrative categories, professional routines, or local power relations remain stable. Conversely, practice can change before formal rules do. The temporal relation among rule, implementation, interpretation, resistance, adaptation, and downstream consequence becomes an empirical question.

Definition 22.754 (Institutional-lineage map). An *institutional-lineage map* records successive formal rules, organizational structures, informal practices, infrastructures, authority relations, implementation routines, memory mechanisms, reform episodes, inherited constraints, and the relations through which earlier institutional arrangements remain active in later configurations.

The map can also identify institutional forgetting. An organization may preserve a rule while losing the historical reason for it, or preserve an archive while losing the capability to interpret it. Such loss can make institutions brittle because participants can reproduce inherited arrangements without understanding the conditions under which they were adaptive. Institutional history therefore interfaces directly with generative return and research infrastructure: preserved memory can become a resource for later adaptation when provenance and interpretability survive.

Institutional histories should also record external relations. Universities, firms, welfare agencies, platforms, public authorities, and commons arrangements evolve through relations with law, finance, technology, professions, political authority, social movements, communities, and international regimes. Treating one institution as an isolated actor can hide the relational conditions of its apparent autonomy.

Proposition 22.755 (Institutional layering condition). *Claims about institutional change should distinguish replacement, layering, reinterpretation, implementation change, and practical persistence because each implies a different historical relation between formal reform and realized economic structure.*

22.18.5 Genealogy

Genealogical research investigates how categories, norms, subject positions, problem definitions, and regimes of evaluation became historically possible and acquired practical authority. Its object is not necessarily the continuous development of an institution. A genealogy can instead ask how a present distinction came to appear natural, why a population became governable through a particular category, how an economic problem was constituted as measurable, or how a norm of productivity, responsibility, risk, deservingness, intelligence, or efficiency became embedded in institutional practice.

For GRE, genealogy is especially valuable where economic relations are stabilized through categories that shape both observation and action. Once a classification is institutionalized, it can influence eligibility, investment, surveillance, self-understanding, market design, and policy. The category can therefore become generative: it helps produce the field that later data appear merely to describe.

Definition 22.756 (Genealogical research profile). A *genealogical research profile* records the focal category, norm, subject position, or problem field; competing historical formulations; sites of articulation; institutional carriers; classificatory and evaluative practices; discontinuities; excluded alternatives; effects on action and observability; and later transformations of the regime in which the object became intelligible.

Genealogy should resist the temptation to replace one simple origin story with another. Multiple lineages can converge, and a category can acquire new functions after its initial formation. Researchers should distinguish evidence of historical constitution from claims about strategic intention. The fact that a category later benefits a powerful institution does not establish that the category was originally designed for

that purpose.

Genealogical findings can revise GRE vocabulary itself. If a supposedly general economic category turns out to depend heavily on a specific historical regime, GRE should not preserve the category merely for theoretical convenience. It can instead localize the concept, construct a historically broader object, or retain multiple versions where no responsible synthesis is available.

Proposition 22.757 (Genealogical contingency condition). *A genealogical GRE claim is strongest when it demonstrates the historical relations through which a category or norm became possible and consequential while preserving discontinuity, competing lineages, and alternatives that the present configuration has obscured.*

22.18.6 Archival Inquiry

Archival inquiry studies historical traces together with the infrastructures that determine which traces survive, how they are classified, who can access them, and what can later be reconstructed from them. An archive is therefore not a transparent container of the past. Selection, custody, arrangement, description, preservation, digitization, secrecy, destruction, privacy rules, and institutional resources shape the evidential field available to later researchers.

GRE archival research should treat absence as structured rather than automatically random. Records may be missing because an activity was informal, because a group lacked institutional capacity to preserve documents, because a regime destroyed evidence, because commercially sensitive records remain closed, because data protection restricts reuse, or because administrative systems never recorded the relevant relation. These mechanisms of absence can themselves be economically important.

Definition 22.758 (Archival provenance and survival profile). *An archival provenance and survival profile records the origin of each relevant trace, its original function, custody history, transformations, classification, survival or loss mechanisms, access conditions, known silences, digitization or transcription history, relation to other holdings, and the inferential consequences of incomplete preservation.*

The profile supports source criticism and also allows archival infrastructures themselves to become research objects. Which institutions can preserve long-run records? Whose transactions receive formal documentation? Which communities maintain oral or local archives? Which data systems create durable provenance, and which replace earlier versions without trace? These questions connect knowledge infrastructure with power and generative capacity.

Archival research should preserve the difference between a record's original purpose and its later analytical use. A tax form, court file, laboratory notebook, platform log, minutes book, personal letter, aid register, or employment record was produced within a specific institutional relation. Later researchers can ask new questions of the trace, but its evidential meaning remains conditioned by the circumstances of production.

Proposition 22.759 (Archival visibility condition). *Historical evidence from archives should be interpreted together with the processes of record production, survival, classification, access, and loss that shaped what became visible to the researcher.*

22.18.7 Ethnography

Ethnographic research reconstructs economic relations through sustained engagement with situated practices. It is particularly valuable where formal categories and official procedures leave important relations tacit, negotiated, embodied, or locally specific. Researchers can observe how people actually coordinate work, interpret rules, maintain infrastructures, navigate scarcity, use AI systems, share knowledge, care for others, negotiate platform requirements, or sustain commons in ways that standardized data may not capture.

GRE ethnography should pay special attention to relations that become visible only through participation or repeated observation. A nominally voluntary arrangement can involve strong dependence; a formal allocation rule can be routinely reinterpreted; an apparently individual capability can depend on collective maintenance; a platform metric can alter practice because participants orient themselves toward anticipated evaluation. Ethnography can reveal these mechanisms before they are easily measurable.

Definition 22.760 (Relational ethnographic field record). *A relational ethnographic field record documents the field boundary, researcher position and access, relevant participants and nonhuman mediators, observed practices, interaction sequences, participant categories, tacit routines, material and digital infrastructures, contested interpretations, changes in researcher relation to the field, and limits on transfer beyond the observed setting.*

The researcher's position is itself part of the evidential configuration. Access can change behavior; trust can reveal some practices while concealing others; institutional affiliation can alter what participants disclose; language and status can shape interpretation. Reflexivity should therefore record material changes in the relation between researcher and field rather than becoming a generic declaration of positionality.

Ethnography can also study historical memory in practice. Participants often carry institutional histories through stories, routines, informal warnings, inherited categories, and embodied skills. These memories should not automatically be treated as accurate chronicles, but they can reveal how the past remains causally active in present interpretation and coordination. Archival and ethnographic materials can then correct one another.

Proposition 22.761 (Situated-practice condition). *Ethnographic evidence is especially valuable for GRE when the research claim concerns how relations, meanings, routines, dependencies, or capabilities are enacted in practice and when the scope of inference remains tied to the field conditions through which those observations became available.*

22.18.8 Legal and Institutional Interpretation

Legal and institutional interpretation reconstructs the rule-governed meanings that constitute or condition economic relations. Property, contract, corporate authority, eligibility, fiduciary obligation, public mandate, intellectual property, administrative discretion, labor status, data access, and organizational responsibility cannot be fully inferred from observed behavior because part of their meaning depends on recognized rules, interpretive practices, and institutional authority.

GRE research should distinguish at least four levels: the formal text or rule; au-

thoritative interpretation; practical implementation; and downstream relational consequence. These levels can diverge. A statute can confer a right whose exercise remains inaccessible; a contract can allocate formal control while technical architecture places effective control elsewhere; an institutional mandate can be interpreted differently across organizations; and informal norms can become highly consequential despite lacking formal legal status.

Definition 22.762 (Legal-institutional interpretation dossier). *A legal-institutional interpretation dossier* records the relevant rule texts and sources of authority, jurisdiction and temporal validity, interpretive institutions, competing readings, implementation practices, enforcement conditions, informal complements, affected positions, practical access to rights or procedures, and observed relational consequences.

The dossier helps prevent a common category error in empirical economic research: treating a legal category as a behavioral variable without reconstructing what the category authorizes, prohibits, recognizes, or constitutes. It also prevents the reverse error of treating formal validity as sufficient evidence of practical effect. GRE needs both because generative opportunity, power, conversion, circulation, and dependency can depend on gaps between formal and effective institutional position.

Interpretation should remain jurisdictionally and historically bounded. A legal term can change through amendment, case law, administrative practice, institutional custom, or interaction with another regime. Comparative legal-economic research should therefore reconstruct the relevant rule system rather than assuming that nominally similar categories have equivalent consequences across jurisdictions.

Proposition 22.763 (Institutional meaning-effect distinction). *A legal or institutional GRE claim should distinguish what a rule or category means within its authoritative order from how that rule is implemented and what relational consequences follow in practice.*

22.18.9 Re-Epistemization

Re-epistemization concerns the disciplined reconstruction of earlier evidence, categories, interpretations, models, and conclusions under later epistemic conditions. New archives can open; new methods can become available; previously separate datasets can be linked; later institutional outcomes can reveal mechanisms that were initially obscure; affected communities can produce alternative records; and conceptual innovations can make old evidence newly question-bearing. GRE treats this possibility as a normal feature of cumulative inquiry.

The central discipline is to preserve the earlier epistemic state while allowing later reinterpretation. A later researcher should be able to distinguish what the original investigator could reasonably observe and infer from what became visible only afterward. Without that distinction, re-analysis can become retrospective correction in which earlier actors are judged as though they possessed later evidence. With the distinction preserved, later knowledge can genuinely revise claim status while maintaining historical fairness to the original inquiry.

Definition 22.764 (Re-epistemization ledger). *A re-epistemization ledger* records the earlier question, evidence set, category system, methods, models, interpretations, uncertainties, and claim status; the later evidence, concepts, methods, or institutional knowledge now available; the transformations linking old and new representations; and the resulting confirmation, weakening, localization, reinterpretation, or rejection

of the earlier claim.

Re-epistemization can operate at several levels. A historical case can be reconstructed with newly available records. A measurement series can be reinterpreted after category drift becomes visible. An institutional intervention can be reassessed after long-horizon consequences emerge. A formal model can be revisited when later evidence shows that an omitted relation was consequential. A participant narrative can be re-read when an institution discloses previously hidden decision processes. These revisions need not erase earlier versions. Preserved superseded interpretations can show how knowledge changed and can protect against repeating failed analytical moves.

Re-epistemization also creates a research-infrastructure requirement. Data, code, archival references, interview protocols, category definitions, model versions, interpretive memos, rejected alternatives, and claim-status records should be preserved sufficiently for later reconstruction where ethics, law, and privacy permit. Preservation has epistemic option value because future questions cannot be fully anticipated at the time of collection.

The process should remain open to negative outcomes. Later evidence can strengthen an earlier claim, but it can also show that the original object was mis-specified, that an apparent mechanism depended on a transient institutional condition, or that a category lacked historical continuity. Such results are productive when the research programme records how and why the claim changed.

Proposition 22.765 (Re-epistemization preservation condition). *Cumulative GRE research is strengthened when earlier evidence, categories, methods, interpretations, uncertainties, and claim states are preserved well enough that later knowledge can revise them without collapsing the distinction between what was knowable then and what became knowable later.*

The historical and interpretive programme therefore gives GRE a disciplined relation to time, meaning, memory, and changing knowledge. Historical reconstruction traces sequences and unrealized alternatives; comparative history tests portability across trajectories; conceptual history follows changing vocabularies; institutional history reconstructs layered rules and practices; genealogy examines the constitution of categories and norms; archival inquiry studies both traces and infrastructures of visibility; ethnography reconstructs enacted relations; legal and institutional interpretation distinguishes rule meaning from implementation and consequence; and re-epistemization makes later revision an explicit research practice.

Proposition 22.766 (Historical-interpretive programme condition). *GRE becomes historically and interpretively answerable when claims about economic relations preserve the sequences, categories, meanings, institutions, evidential traces, situated interpretations, and later epistemic transformations on which those claims depend, and when disagreement among reconstructions remains visible enough to guide further inquiry.*

The programme does not compete with quantitative or formal research for a single privileged representation of economic reality. It identifies dimensions of evidence that can be lost when time, meaning, institutional constitution, and provenance are compressed too early. The next section develops the quantitative and empirical programme required to measure, compare, estimate, and test relational economic claims while preserving these historical and interpretive dependencies where they are material to inference.

22.19 Quantitative and Empirical Research Programme

The role of this section is to specify how quantitative and empirical designs can test, estimate, compare, and revise claims generated by the GRE research programme. The objective is not to reproduce the quantitative methods surveyed earlier in the book. It is to define the research interface through which relational architecture, generative trajectories, value conversion, circulation, return, power, justice, exploitation, epistemic economy, and capability asymmetry become empirically answerable under explicit measurement and identification conditions. The programme therefore begins from a GRE claim and asks what must be observed, sampled, measured, compared, assigned, modeled, or followed through time for that claim to acquire quantitative warrant.

The discussion proceeds through measurement, surveys, longitudinal data, panel data, experiments, quasi-experiments, causal inference, relational statistics, simulation validation, and cross-method triangulation. These designs answer different questions. A survey can estimate distributions of reported experience without establishing the institutional mechanism that generated them. Longitudinal records can reveal temporal ordering without by themselves identifying a causal effect. Randomized experiments can identify a treatment contrast under a specified assignment process while leaving long-horizon transfer open. Relational statistics can represent dependence among observations while remaining descriptive if the identifying assumptions required for a causal claim are absent. Simulation can establish consequences of a model under stated assumptions, but its agreement with its own construction is not empirical validation. GRE therefore treats quantitative strength as design-indexed rather than as a generic property of numerical analysis.

The empirical programme also preserves the distinction between a relational or generative research object and its measurable manifestations. A relation can be partially observed through transactions, communication, reported dependence, legal roles, co-presence, resource flows, network ties, or institutional records. Generative capacity can be approached through later options, realized capabilities, learning, persistence, entry into new relations, or changes in dependence. None of these manifestations is automatically identical to the underlying analytical construct. The quantitative programme consequently records the transformations through which evidence becomes a variable and the inferential steps through which variables support a GRE claim.

Definition 22.767 (Empirical research dossier). A *quantitative-empirical research dossier* records the GRE claim under investigation, the target population or configuration, unit and level of observation, estimand or descriptive target, operationalized manifestations, sampling or assignment process, temporal and spatial boundaries, dependence and interference structure, missingness and selection processes, identifying assumptions, uncertainty model, validation strategy, historical and institutional conditions, competing explanations, transfer scope, and conditions under which the claim should be revised.

Definition 22.767 makes explicit that an estimate is one component of a larger evidential architecture. The same numerical contrast can support different claims depending on the population sampled, the construct measured, the exposure defined, the relations omitted, and the period over which outcomes are observed. Conversely, several estimates produced by different designs can concern different manifestations

Table 22.19: Principal domains in the GRE quantitative and empirical research programme

Research domain	Primary empirical object	Principal inferential burden
Measurement	Manifestations, indicators, scales, and constructed variables	Preserve construct meaning, comparability, uncertainty, and transformation provenance
Surveys	Reported states, relations, expectations, experiences, and positions	Match respondents, sampling frame, question form, and inference target
Longitudinal data	Trajectories, events, delayed effects, and temporal change	Preserve timing, category continuity, exposure history, and observation processes
Panel data	Repeated observations of units and relations	Track identity, membership, attrition, relation turnover, and changing composition
Experiments	Assigned interventions or exposures and resulting contrasts	Specify treatment, interference, compliance, outcome horizon, and local scope
Quasi-experiments	Institutionally generated or discontinuous variation	Reconstruct the assignment mechanism and defend design-specific identification assumptions
Causal inference	Effects of interventions, exposures, and relational changes	Define counterfactual contrast, dependence, mediation, horizon, and causal scope
Relational statistics	Dyadic, networked, multilevel, or higher-order dependence	Align statistical units and dependence assumptions with the relational object
Simulation validation	Empirical adequacy of computational mechanisms and trajectories	Separate verification, calibration, empirical validation, sensitivity, and transfer
Cross-method triangulation	Convergence and contradiction across evidential modes	Localize disagreement rather than averaging away incompatible objects or assumptions

of the same GRE object and therefore require translation before they are compared.

Proposition 22.768 (Design-indexed empirical warrant). *The quantitative warrant of a GRE claim is strengthened when the research object, manifestation, estimand, sampling or assignment process, dependence structure, identification assumptions, uncertainty, and transfer scope are sufficiently explicit that alternative explanations and failure conditions can be examined independently of the numerical result itself.*

Table 22.19 summarizes the principal empirical programmes and their characteristic inferential burdens.

22.19.1 Measurement

Measurement is the entry point through which a GRE research object becomes available for quantitative comparison. The programme treats measurement as a transformation from a conceptually and historically specified object into one or more observable manifestations, coding rules, scales, or derived quantities. This transformation can preserve some dimensions while compressing others. A monetary amount can measure one manifestation of value while leaving recognition, care, ecological consequence, or future option creation outside the variable. A network tie can represent one relation while ignoring the content, legal standing, intensity, temporality, or asymmetry that makes the relation economically consequential.

The first research task is therefore to separate the construct from the indicator. A study of generative opportunity might use educational transition, access to infrastructure, number of feasible occupational pathways, entry into new collaborations, or changes in effective exit options as evidence. Each indicator captures a different manifestation. GRE does not require that these manifestations be collapsed into one index. Where aggregation is useful, the weighting and substitution rules become substantive assumptions that should be recorded rather than treated as technical defaults.

Measurement also requires attention to relational location. The same resource can have different effective meanings depending on access to complements, institutional

recognition, network position, legal status, or conversion interfaces. An individual-level quantity can therefore be insufficient when the construct is relationally constituted. Researchers may need dyadic indicators, group-level measures, organizational variables, multiplex records, or configuration-level features. The unit of measurement should follow the research object as closely as feasible.

Definition 22.769 (Empirical operationalization profile). An *empirical operationalization profile* records the GRE construct, observable manifestation or proxy, unit and level of measurement, coding or scaling procedure, temporal reference, comparison class, known dimensions omitted by the measure, validation evidence, measurement uncertainty, and assumptions required for comparison across positions, institutions, groups, or time.

The profile is especially important for longitudinal and comparative work because measurement equivalence can fail even when variable names remain stable. Survey categories can change meaning; institutional classifications can be revised; administrative eligibility rules can alter the population entering a category; platform metrics can be redefined; prices can preserve units while the practical bundle they command changes. Quantitative continuity should therefore be demonstrated rather than inferred from nominal continuity.

Measurement error can itself be relationally structured. Actors with weak institutional visibility can be under-recorded. Informal relations can disappear from administrative datasets. Highly powerful organizations can define reporting categories, while marginal positions may have little influence over what becomes measurable. GRE empirical research should therefore examine whether the measurement infrastructure differentially renders some positions visible, comparable, or governable.

Proposition 22.770 (Measurement portability condition). *A quantitative measure is portable across cases or time only to the extent that the construct, manifestation, coding relation, and relevant institutional conditions remain sufficiently comparable for the intended inference.*

The later measurement-focused section examines difficult GRE constructs in greater detail. The present subsection establishes the programme-level rule: empirical precision cannot compensate for a transformation whose relation to the research object is unclear.

22.19.2 Surveys

Surveys provide a flexible means of studying reported experience, perceived dependence, expectations, values, access, trust, recognition, participation, exposure, and relational position. Their GRE value is greatest when the design makes explicit who can report on which object. Respondents can often report their own experience, perceived alternatives, or remembered interactions; they may have limited knowledge of organization-wide flows, hidden institutional decisions, other actors' intentions, or network structure beyond their immediate position. A survey item should therefore be interpreted according to the epistemic access of the respondent.

Sampling requires a similarly relational discipline. Household, individual, organization, dyad, community, platform-user, or institutional-role sampling frames produce different populations of inference. A conventional individual sampling frame can omit relations that cross households, organizations, jurisdictions, or formal membership categories. Snowball or network-based recruitment can improve access to

some relational structures while introducing dependence and selection that must be modeled or bounded. Repeated surveys can reveal changing perceptions while still requiring care about cohort replacement and category drift.

Question design should distinguish factual reports, evaluations, expectations, normative judgments, and relational perceptions. A question such as whether an actor is “dependent” on an institution may capture perceived lack of alternatives, emotional attachment, legal restriction, material necessity, or some combination. GRE studies should decompose such constructs where the distinction matters to the claim. Vignettes, paired comparisons, roster questions, name generators, institutional scenarios, and structured recall can be useful when ordinary single-item questions compress the relevant relation too aggressively.

Definition 22.771 (Relational survey design profile). *A relational survey design profile records the target population, sampling frame, respondent position, relation or construct queried, respondent access to the requested information, question form, temporal reference, dyadic or group linkage where applicable, nonresponse pathways, weighting or adjustment strategy, and the inferential boundary between reported perception and externally reconstructed relation.*

Nonresponse deserves substantive interpretation. Refusal, noncontact, language mismatch, institutional distrust, digital exclusion, mobility, care burden, legal risk, or organizational gatekeeping can create patterned absence. Adjustment through weighting or imputation may be appropriate under specified assumptions, but the pattern of absence can itself provide evidence about institutional access or visibility. Survey research should preserve the provenance of missingness rather than treating all missing responses as equivalent.

Survey results can also be linked with administrative records, network data, interviews, or institutional documents. Such linkage can reveal systematic gaps between formal entitlement and experienced access, between recorded participation and perceived influence, or between reported trust and observed dependence. These differences need not indicate that one source is defective. They can identify distinct manifestations of the same relational configuration.

Proposition 22.772 (Survey inferential boundary). *Survey evidence supports a GRE claim most directly about the populations, reported manifestations, and relational positions represented by the design; claims about hidden mechanisms, unobserved relations, or institution-wide structure require additional evidence or explicit modeling assumptions.*

22.19.3 Longitudinal Data

Longitudinal data are central to GRE because generativity, return, institutional transformation, power persistence, dependency, and capability development are temporal claims. A cross-sectional association can indicate a relation at one moment while remaining unable to distinguish accumulation, delayed consequence, adaptation, selection, or historical sequencing. Longitudinal design makes these processes more observable by following variables, events, relations, institutions, or populations across time.

The relevant clock need not be uniform. Financial transactions can change daily, organizational roles monthly, educational trajectories over years, institutional conventions over decades, and ecological regeneration over still longer horizons. GRE re-

search should choose temporal resolution according to the mechanism under study and should record when fast variables are being used as proxies for slower transformations. Excessively coarse intervals can hide transient events; excessively fine intervals can create apparent volatility without improving understanding of the generative process.

A second issue is temporal alignment. Exposure, mediation, outcome, return, and downstream capacity may occur at different times. If an intervention provides immediate resources but its capability effects appear after training, institutional recognition, or network entry, a short outcome window can misclassify delayed generation as absence of effect. Conversely, long windows can incorporate later shocks that weaken attribution. The empirical design should therefore specify expected lags and alternative temporal pathways before interpreting persistence or delay.

Definition 22.773 (Temporal observation architecture). *A temporal observation architecture records the processes under study, observation interval, event-time anchors, exposure histories, anticipated lags, persistence criteria, temporal aggregation rules, category changes, observation gaps, competing periodizations, and the horizon over which descriptive or causal claims are intended to hold.*

Longitudinal datasets also face historical discontinuity. Institutions merge, jurisdictions change, survey instruments are redesigned, identifiers are replaced, platforms modify logging practices, and concepts change meaning. A continuous time series can therefore contain breaks in what is being observed. Researchers should version measurement rules and, where possible, provide bridges that permit comparison across regimes without asserting equivalence that the data cannot support.

Event histories can be especially useful for generative analysis. Entry into an institution, formation or dissolution of a relation, conversion of a resource, loss of access, migration, legal recognition, technological adoption, or institutional reform can define events whose timing alters later possibility. Recurrent-event and sequence approaches can then distinguish one-off transitions from patterned recurrence, while qualitative or historical evidence can help interpret why apparently similar events have different consequences.

Proposition 22.774 (Temporal claim condition). *A longitudinal GRE claim is strengthened when the observation interval, event timing, exposure history, lag structure, category continuity, and outcome horizon correspond to the temporal mechanism asserted by the claim.*

22.19.4 Panel Data

Panel data provide repeated observations on identified units and therefore permit stronger analysis of within-unit change, persistent heterogeneity, entry and exit, and temporal ordering. GRE extends the design problem by asking whether the unit itself remains comparable through time. Individuals change institutional position; households split and merge; organizations reorganize; communities acquire or lose members; dyads dissolve; platform accounts change ownership or function; and relational configurations can transform even when identifiers remain stable.

The panel unit should therefore be paired with an identity rule. For a person-level panel, continuity may be relatively straightforward while relational exposure changes substantially. For an organizational panel, a merger can create a new effective entity despite administrative continuity. For a dyadic panel, the meaning of an

observed tie can change as authority, contract, or dependence changes. Researchers should state what kind of persistence is assumed and which changes are treated as covariates, outcomes, or breaks in identity.

Attrition creates another major challenge. Exit from the panel can be random with respect to the target claim, but in many GRE settings it is itself generated by migration, institutional exclusion, relationship dissolution, conflict, poverty, platform exit, care obligations, organizational failure, or death. Such attrition can contain direct information about the process being studied. Statistical correction may still be useful, yet interpretation should preserve the substantive pathway through which observation ended.

Definition 22.775 (Relational panel schema). A *relational panel schema* records the repeated unit, identity and persistence rule, time-varying relations and memberships, entry and exit processes, attrition and replacement mechanisms, within-unit and between-unit estimands, changing measurement conditions, exposure history, and higher-level configurations that may alter the meaning of repeated observations.

Panel designs can combine individual, relational, and institutional levels. Repeated observations of workers can be linked to changing firms, teams, technologies, contracts, and local labor markets. Repeated observations of students can be linked to classrooms, teachers, schools, households, and credential regimes. These multilevel panels make it possible to distinguish change associated with an individual trajectory from change associated with movement across relational environments.

Fixed-effect, random-effect, dynamic, multilevel, event-history, and other panel approaches can each be useful, but the research question should determine the model rather than the availability of a standard estimator. If a theoretically consequential variable changes little within units, a within-unit estimator can answer a narrower question than the substantive claim. If past outcomes affect later exposure, dynamic dependence should be treated explicitly. GRE therefore emphasizes estimand-model correspondence rather than privileging one panel technique.

Proposition 22.776 (Identity-aware panel condition). *Panel evidence is most informative for GRE when continuity of the repeated unit, changes in its relational environment, entry and exit, and the source of within-unit variation are specified separately rather than being absorbed into an unchanged identifier.*

22.19.5 Experiments

Experiments can test GRE mechanisms by deliberately varying an exposure or intervention under an explicit assignment procedure. Their principal advantage is control over assignment, which can support strong local causal contrasts when randomization, compliance, outcome observation, and analysis correspond to the research question. GRE adds special attention to relational interference and to outcomes that change the environment in which other units operate.

Treatment can occur at several levels. A resource may be assigned to individuals; an information regime to teams; a governance rule to communities; an interface to platform users; a coordination protocol to organizations; or a network intervention to selected positions. The unit of randomization and the unit of analysis need not coincide. If treatment affects untreated neighbors, alters congestion, changes prices, modifies norms, or reconfigures institutional behavior, isolated-unit estimands can fail to capture the mechanism of interest.

The outcome horizon also matters. Many GRE hypotheses concern generated capabilities, new relations, learning, return flows, institutional adaptation, or option expansion. Immediate behavioral response can be a useful intermediate outcome while remaining insufficient evidence for durable generativity. Experiments should therefore distinguish short-run response, mediation, persistence, spillover, and later generative consequence where the theory requires those stages.

Definition 22.777 (Relational experimental design). *A relational experimental design records the intervention, randomization unit, treatment versions, exposure mapping, compliance process, interference pathways, primary and downstream outcomes, observation horizon, subgroup and relational-position hypotheses, stopping or adaptation rules, and the population and configuration to which the experimental contrast is intended to apply.*

Mechanism experiments can be especially valuable when a complex GRE concept can be decomposed into testable pathways. For example, a study of conversion power might experimentally vary access to a credentialing interface while holding nominal resources constant. A study of epistemic abundance might vary filtering or verification support rather than information quantity alone. Such experiments can discriminate among mechanisms even when they do not reproduce the full institutional field.

Experimental simplicity should therefore be interpreted as local control, not as proof that the isolated mechanism dominates outside the experimental setting. A highly controlled result can establish that a mechanism can operate under specified conditions. Transfer to a historical institution, another population, or a long-horizon relational system requires additional evidence about whether the relevant complements and constraints are present.

Proposition 22.778 (Experimental localization condition). *An experimental GRE result warrants a causal claim at the level defined by its assignment, treatment, exposure, interference, outcome, and population; broader claims about relational transformation or generative persistence require evidence that the experimentally isolated mechanism survives the relevant institutional and temporal conditions.*

22.19.6 Quasi-Experiments

Quasi-experimental research uses institutional rules, thresholds, timing differences, policy changes, shocks, or other assignment processes that create informative variation without researcher randomization. Such designs are particularly important for GRE because many consequential economic relations cannot ethically or practically be randomized. Legal reforms, administrative thresholds, phased infrastructure, platform rule changes, eligibility criteria, geographic boundaries, and organizational restructurings can create opportunities for stronger causal identification.

The design begins with reconstruction of the assignment mechanism. A discontinuity in observed treatment is useful only if the rule generating that discontinuity is understood well enough to defend the comparison. A policy adopted in one jurisdiction and not another can support comparison only under assumptions about pre-existing trends, concurrent changes, selection into adoption, spillovers, and measurement continuity. Historical and institutional inquiry from Section 22.18 is therefore often part of the identification strategy rather than an optional contextual supplement.

Definition 22.779 (Quasi-experimental identification dossier). *A quasi-experimental*

identification dossier records the institutional or historical source of variation, assignment rule or process, comparison groups or thresholds, timing, exposure and spillover pathways, design-specific identifying assumptions, diagnostics, concurrent interventions, manipulation risks, outcome horizon, and the local population for which the causal contrast is claimed.

Different quasi-experimental designs answer differently localized questions. Threshold designs may identify effects near an eligibility cutoff. Difference-based designs can estimate changes relative to comparison trajectories when their assumptions are plausible. Instrumental strategies can identify effects for populations whose exposure is shifted by the instrument under additional restrictions. Matching and weighting can improve observed comparability while remaining vulnerable to unmeasured differences. GRE should state these local targets rather than translating them immediately into universal properties of a relation or institution.

Quasi-experiments can also reveal relational spillovers that violate a naive design. A policy in one region can shift migration, prices, service demand, information, or organizational behavior in neighboring regions. Eligibility assigned to one household member can alter outcomes for others. A platform rule applied to one user class can change market conditions for untreated users. Such interference can weaken a conventional estimator while also revealing the relational mechanism that GRE seeks to understand.

Proposition 22.780 (Assignment-mechanism condition). *The credibility of a quasi-experimental GRE claim depends on an empirically and institutionally supported account of how exposure was generated, which comparisons the assignment process licenses, and which spillovers or concurrent changes can invalidate those comparisons.*

22.19.7 Causal Inference

Causal inference in GRE asks how a specified intervention, exposure, relation, institutional rule, or configuration changes an outcome relative to a defined alternative. The programme retains ordinary distinctions among association, prediction, mechanism evidence, and causal effect while extending the causal object beyond isolated units. Treatments can be relational; outcomes can occur at multiple scales; one unit's treatment can alter another unit's exposure; and the intervention itself can change the network or institution through which later effects propagate.

A causal question should first specify the contrast. The effect of “access,” “power,” “AI,” “institutional support,” or “community participation” is not a single quantity until exposure versions, comparison states, population, time horizon, and outcome are defined. GRE concepts often contain several mechanisms, so a broad label can conceal materially different interventions. Access through a public entitlement, private subscription, social connection, or algorithmic allocation can generate different downstream relations even if the immediate resource appears similar.

Temporal ordering alone remains insufficient. Researchers should identify plausible confounders, selection processes, mediators, moderators, interference, and feedback. Historical evidence can help identify prior institutional causes; qualitative evidence can reveal treatment versions or hidden selection; formal models can clarify dynamic feedback; and statistical designs can estimate contrasts under stated assumptions. Causal inference is therefore compatible with methodological pluralism because identification often depends on knowledge that is not contained in the final

estimation equation.

Definition 22.781 (Generative causal claim profile). A *generative causal claim profile* records the intervention or exposure, causal unit or relational configuration, comparison state, outcome and its scale, exposure timing, mediation pathways, interference and spillover structure, feedback, identification strategy, uncertainty, effect heterogeneity, persistence horizon, and the additional evidence required to infer downstream generative consequence.

The last element is important. A causal estimate of an immediate outcome does not automatically establish a causal effect on future generative capacity. The pathway may require several stages: an intervention changes access; access changes participation; participation changes learning or recognition; those changes alter later options; and the new options persist under changing institutional conditions. Each stage can fail or be moderated by another relation. GRE should therefore distinguish a directly identified treatment effect from a longer generative causal chain.

Causal graphs, potential-outcome formulations, structural models, process tracing, and other causal languages can each be useful when their assumptions are explicit. The choice depends on whether the main problem is assignment, mediation, dynamic feedback, interference, latent structure, or historical sequence. Formal equivalence among some representations does not erase differences in what researchers can actually identify from available data.

Proposition 22.782 (Generative causal escalation condition). A *causal claim about a downstream generative consequence requires evidential support for the links connecting the identified intervention or exposure to the later change in capability, relation, option, institution, or regenerative process; an identified proximal effect warrants only the proximal causal claim.*

22.19.8 Relational Statistics

Relational statistics analyze observations whose dependence structure is part of the research object rather than merely a nuisance. Dyads, networks, teams, households, organizations, nested institutions, repeated interactions, spatial neighbors, and higher-order groups can generate dependence that violates isolated-observation assumptions. GRE uses relational statistics when the configuration of relations carries substantive information about access, diffusion, coordination, segregation, power, return, or generativity.

The first design decision concerns the statistical unit. An individual dataset with a few network covariates remains different from a dyadic dataset in which ties are observations, and both differ from a whole-network design in which global structure matters. Hyperedges or group events may be needed when a relation is irreducibly collective. Multilevel models can represent nesting, while spatial and temporal models can capture dependence generated by proximity or shared exposure. The representation should correspond to the mechanism rather than defaulting to pairwise ties whenever the word “relational” appears.

Definition 22.783 (Relational statistical specification). A *relational statistical specification* records the observational units, relation types, direction and weighting where applicable, higher-order or multilevel structure, dependence assumptions, temporal evolution, boundary construction, sampling process, missing relations, uncertainty representation, and the inferential target associated with the modeled configuration.

Boundary construction is especially consequential. A network can appear centralized or fragmented because relevant external actors are excluded. Organizational data can treat a formal department as the system even when authority is exercised elsewhere. Cross-platform or cross-jurisdiction relations can disappear at the data boundary. Sensitivity to boundary definitions should therefore be part of relational statistical analysis rather than reserved for a later robustness check.

Relational statistics can support descriptive, predictive, or causal claims, but the modes should remain separate. Centrality, clustering, assortativity, community structure, latent position, or relational regression can describe organization without identifying why it arose. Predictive performance can reveal stable association without licensing intervention claims. Causal inference with networks requires additional assumptions about exposure, interference, confounding, and counterfactual structure.

Proposition 22.784 (Relational statistical unit condition). *A relational statistical result is interpretable for GRE when the statistical unit, dependence structure, system boundary, and modeled relation correspond closely enough to the substantive relational object that changes in the estimate can be translated back into changes in the economic configuration under study.*

22.19.9 Simulation Validation

Simulation provides a bridge between the formal programme of Section 22.17 and empirical research when analytic solutions are unavailable, many interacting mechanisms operate jointly, or the research question concerns trajectories generated under alternative assumptions. Agent-based models, stochastic simulations, network dynamics, field models, and history-dependent models can generate distributions and pathways that are then compared with empirical evidence. Their evidential role depends on separating model verification from empirical validation.

Verification asks whether the implementation correctly executes the specified model. Calibration chooses or estimates parameters so that the simulation corresponds to designated evidence or targets. Validation asks whether outputs, mechanisms, or trajectories provide an adequate account of evidence not guaranteed by the calibration procedure. Sensitivity analysis asks which conclusions survive plausible changes in parameters, structure, initial conditions, or stochastic realization. These tasks should not be collapsed into a single statement that the model “fits.”

Definition 22.785 (Simulation evidence bridge). *A simulation evidence bridge records the formal model, implementation version, parameter provenance, initialization, calibration targets, empirical validation targets, mechanism-level observables, stochastic uncertainty, sensitivity range, alternative model structures, historical or institutional boundary conditions, and the claim that the simulation is intended to support.*

GRE simulations can be validated at several levels. Distributional validation compares simulated and observed distributions. Temporal validation compares event timing or trajectories. Relational validation compares network or institutional patterns. Mechanism validation examines whether the simulated pathways correspond to process evidence. Historical validation tests whether the model can reproduce or distinguish known sequences under appropriately reconstructed conditions. A model can perform well at one level and poorly at another; the validation record should preserve that pattern.

Out-of-sample or out-of-period prediction can provide strong evidence for some

purposes, but it is not the only validation criterion. A historically specific institutional mechanism may not be expected to predict another regime. Conversely, a model designed to reproduce one historical case can overfit that case while lacking transferable structure. Model comparison should therefore ask which evidence was used for construction, which for calibration, which for validation, and what kind of portability is being claimed.

Simulation can also generate counterevidence. If a hypothesized mechanism cannot reproduce a robust empirical pattern across plausible parameter ranges, or if it requires parameter values incompatible with observed institutions, the result should weaken the mechanism claim. Negative simulation results are therefore part of the empirical programme rather than failed technical exercises.

Proposition 22.786 (Simulation validation condition). *A simulation contributes empirical warrant to GRE when agreement with evidence is evaluated against targets that are not merely consequences of the model's own construction or calibration, and when implementation, parameter provenance, uncertainty, sensitivity, and competing model structures remain inspectable.*

22.19.10 Cross-Method Triangulation

Cross-method triangulation tests a GRE claim through evidential routes that can differ in manifestation, scale, and assumption. Its objective is structured comparison rather than numerical averaging: convergence and contradiction become informative when the role and limits of each method are explicit.

A strong triangulation design begins with claim decomposition. Administrative data may establish distribution, surveys experienced constraint, institutional records an allocation rule, interviews informal gatekeeping, and a quasi-experimental design the effect of a rule change. Combined warrant depends on how these evidential roles connect, not on the number of methods used.

Definition 22.787 (Cross-method triangulation matrix). *A cross-method triangulation matrix records the focal GRE claim, its component subclaims, methods used, manifestations accessed by each method, populations and scales, principal assumptions, convergent findings, contradictions, evidential gaps, translation limits, and the claim revision implied by the combined evidence.*

Contradiction is analytically valuable. Survey and administrative evidence can diverge because experience differs from the formal record, populations or timing differ, measurement is invalid, or institutional data capture only visible parts of a process. Historical and ethnographic evidence can help localize the disagreement rather than treating the more quantitative source as automatically decisive.

Triangulation also guards against synchronized error: datasets can share one classification, interviews one institutional narrative, and simulations and regressions one omitted assumption. Method diversity contributes most when evidential sources and failure modes are genuinely heterogeneous.

The historical and interpretive programme in Section 22.18 and the formal programme in Section 22.17 are therefore partners of quantitative inquiry. Historical work can reveal category change and assignment mechanisms, interpretation can clarify meaning and implementation, formal work can expose dependencies, and quantitative designs can estimate distributions, dynamics, contrasts, and effects.

Proposition 22.788 (Triangulation revision condition). *Cross-method triangulation strengthens a GRE claim when independent evidential routes support compatible component claims, and it strengthens the research programme when contradictions are preserved and localized well enough to revise the object, measurement, mechanism, scope, or claim status.*

The quantitative and empirical programme makes GRE numerically answerable while preserving object specification, history, interpretation, and formal clarity. Measurement connects constructs to manifestations; longitudinal and panel designs follow change; experimental and quasi-experimental designs support local contrasts; causal inference specifies intervention claims; relational statistics model dependence; simulation validation connects models with evidence; and triangulation integrates distinct evidential modes.

Proposition 22.789 (Quantitative-empirical programme condition). *GRE becomes quantitatively and empirically answerable when numerical claims preserve the transformations linking research objects to observations, the designs linking observations to estimands, the assumptions linking estimands to inference, and the historical, relational, and institutional conditions that delimit transfer and revision.*

The programme also interfaces with comparative theory, institutional experimentation, measurement research, falsification, negative results, replication, and research infrastructure. Quantitative inquiry thereby enters GRE as a cumulative and revisable evidential mode within a wider research architecture.

22.20 Comparative Theory Programme

Chapter 21 established theoretical dialogue as a substantive part of Generative Relational Economics (GRE): economic theories can be translated partially, compared through scoped equivalence relations, coordinated in multi-theoretical explanations, and retained in disagreement when their constitutive commitments remain different. The role of the present section is to convert that dialogical architecture into a repeatable research programme. Its objective is to specify research procedures for cross-theory translation, comparison among competing explanations, domain-of-adequacy analysis, theory combination, theory conflict, theory revision, negative translation results, and theoretically plural inquiry. The method is metatheoretical and comparative, with empirical, historical, formal, interpretive, and normative interfaces. The section therefore treats theories as research objects whose claims, assumptions, mechanisms, evidential requirements, and revision conditions can themselves be investigated.

Comparative theory research differs from a survey of schools of thought. A survey can reconstruct positions accurately while leaving unclear how one would determine whether a theoretical difference matters for explanation, evidence, prediction, interpretation, or evaluation. A comparative programme requires a more explicit unit of work: a specified phenomenon or question, several theory-relative representations of it, the claims each representation licenses, the evidence each claim requires, and a record of what survives or fails when the theories are brought into contact.

A further difficulty is that the comparison object cannot simply be named in the vocabulary of one participating theory. If an inquiry defines the focal phenomenon in advance as a market failure, a class relation, a capability deprivation, a coordination

problem, a field position, a care deficit, or a generative-capacity loss, part of the theoretical contest may already have been settled by description. Comparative inquiry therefore needs a distinction between the manifestations or cases jointly under examination and the theory-specific objects through which those manifestations become explanatory.

Definition 22.790 (Comparative-theory research dossier). A *comparative-theory research dossier* records the focal question or case, shared manifestations available for comparison, participating theories, theory-specific object constructions, principal concepts and mechanisms, scope and boundary conditions, evidential requirements, normative commitments where relevant, translation attempts, discriminating observations, unresolved remainders, and the revision consequences of the comparison.

The dossier makes theoretical comparison traceable. It permits a researcher to ask whether two theories are genuinely addressing the same manifestation, whether they construct different objects from it, whether their mechanisms compete or operate at different levels, and whether a disagreement is empirical, formal, interpretive, normative, or constitutive. Table 22.20 summarizes the principal comparative operations developed below.

22.20.1 Cross-Theory Translation

Cross-theory translation is the first operation because comparison requires some common coordinate without presupposing theoretical identity. Chapter 21 distinguished conceptual, functional, structural, historical, cross-scale, value-regime, and loss-aware translation. The research-programme problem is narrower and more procedural: how should a proposed translation be tested when it is used to support an actual comparative claim?

A translation should be indexed to a purpose. Translating “capital” into a generic resource stock can be adequate for one descriptive question and destructive for another in which ownership, social relation, temporal accumulation, or power is the mechanism of interest. Translating capability into future option space can illuminate one dimension while leaving evaluative freedom, conversion conditions, and person-specific heterogeneity unresolved. The same mapping can therefore be adequate for one claim and inadequate for another.

Definition 22.791 (Claim-indexed translation trial). A *claim-indexed translation trial* specifies a source-theoretical object, target-theoretical object, focal research claim, proposed correspondence, properties intended to be preserved, properties allowed to differ, evidential or interpretive tests of preservation, expected translation loss, stopping conditions, and the consequences of success or failure for the focal claim.

The trial can use several kinds of evidence. Conceptual translation may require comparison of inferential roles and contrasts in texts or formal definitions. Structural translation may require demonstration that the relevant relations, directions, or compositions are preserved. Historical translation may require sequence-sensitive reconstruction. Functional translation may require evidence that differently constituted arrangements actually perform the specified function under comparable conditions. Value-regime translation may require explicit governance of commensuration and residual value dimensions.

Translation should also be directional. A mapping from a rich institutional theory into a sparse formal model can preserve a mechanism while losing historical and

Table 22.20: Principal operations in the GRE comparative theory programme

Comparative operation	Primary object	Research output	Principal failure risk
Cross-theory translation	Concepts, mechanisms, structures, scales, value regimes, and warrants	Claim-indexed translation record with preserved content and remainders	Lexical similarity or common vocabulary mistaken for equivalence
Competing explanations	Alternative mechanisms for a shared case or manifestation	Comparative explanation matrix and comparative evidence plan	One theory defining the observation so that rivals cannot be fairly tested
Domain of adequacy	Conditions under which a theory performs specified explanatory work	Domain profile with boundary, transport, and failure conditions	Local success generalized beyond its supporting regime
Theory combination	Differentiated contributions to one research object	Composition architecture with interfaces and division of explanatory labor	Additive eclecticism or hidden double counting
Theory conflict	Incompatible claims, mechanisms, standards, or commitments	Conflict dossier and adjudication or preservation rule	Treating constitutive disagreement as a data problem, or vice versa
Theory revision	Comparison-supported change in a theoretical configuration	Versioned revision record with retained, modified, and abandoned claims	Ad hoc accommodation that preserves the theory against all possible evidence
Negative translation	Material failure of a proposed mapping	Negative-translation ledger and re-entry conditions	Failed translation discarded and repeatedly rediscovered
Theoretical pluralism	Portfolio of theories retained for differentiated research purposes	Pluralism portfolio with roles, overlaps, exclusions, and revision rules	Unstructured “anything goes” coexistence without comparative accountability

normative detail; the reverse mapping may add interpretive content that the model did not establish. The comparative programme should therefore record source and target explicitly rather than treating translation as a symmetric synonym relation.

Proposition 22.792 (Claim-relative translation warrant). *A cross-theory translation warrants comparative use when the properties material to the focal claim are demonstrably preserved, the direction and losses of the mapping are recorded, and the comparison does not rely on properties that the translation leaves unresolved.*

Translation trials can be cumulative. A mapping that repeatedly preserves a specified relation across cases can acquire stronger comparative standing within that domain. A mapping that works only under narrow institutional or historical conditions can be retained with those conditions attached. A mapping that fails can become a

negative result rather than disappearing from the programme. In this way, theoretical translation becomes an object of research rather than a one-time act of interpretation.

22.20.2 Competing Explanations

Competing explanations arise when two or more theories offer materially different accounts of a case, pattern, event, or trajectory. The comparison can concern different mechanisms for a shared manifestation, different causal priorities, different units of analysis, different temporal sequences, or different claims about what requires explanation. Competitive comparison is most informative when the alternatives generate observations that could distinguish among them.

The first task is comparison-object construction. Researchers should identify manifestations available across theoretical vocabularies before translating them into one theory's explanatory terms. Examples include a persistent wage differential, repeated platform exit, a change in household labor allocation, a credit freeze, a common-resource collapse, a productivity divergence, or unequal access to an educational institution. These descriptions are not fully theory-neutral, because observation always depends on categories, but they can be made sufficiently thin and explicit to prevent one theory from defining the contest in advance.

Definition 22.793 (Comparative explanation matrix). *A comparative explanation matrix records a shared case or manifestation, each participating theory's constructed object, proposed mechanism, relevant initial and boundary conditions, expected intermediate processes, observable implications, evidential requirements, alternative interpretations, and observations whose occurrence would strengthen, weaken, or leave unchanged the comparative standing of each explanation.*

The matrix should distinguish predictions from retrodictions and explanatory accommodations. A theory can explain an already observed event by showing that its mechanism makes the event intelligible without having predicted it in advance. That can be valuable, especially in historically contingent systems. Its evidential weight nevertheless differs from a risky prediction or from independent mechanism evidence obtained before outcome inspection. Comparative research should record this temporal relation between theory, evidence, and claim construction.

Competition can also be partial. One theory may explain initiation and another persistence. One may explain aggregate demand while another explains distributional incidence. One may account for institutional formation and another for short-run behavioral response. In such cases, a discriminating matrix can reveal that the theories were initially treated as rivals only because their explanatory levels or temporal horizons were compressed.

Proposition 22.794 (Comparative discrimination condition). *Competing theories are empirically comparable to the extent that their claims can be related to a shared case through distinguishable mechanisms, implications, or evidential requirements; where those discriminators are absent, the comparison should remain interpretive, formal, normative, or scope-relative rather than being presented as empirical adjudication.*

The proposition protects comparative inquiry from artificial contests. Some disagreements can be tested through data. Others concern different normative standards, ontological commitments, or meanings of the economic object. The programme gains rigor by identifying which type of disagreement is present before

selecting an adjudication procedure.

22.20.3 Domain of Adequacy

Theories can perform strongly within limited domains without functioning as general descriptions of economic reality. A comparative research programme therefore needs to investigate where a theory is adequate, for what purpose, at what scale, over what horizon, and under which institutional or historical conditions. Domain analysis turns theoretical scope from a rhetorical claim into a research object.

Adequacy is multidimensional. A theory can provide accurate short-run prediction while offering a weak account of institutional formation. Another can explain historical transformation while being poorly suited to local quantitative forecasting. A third can clarify normative stakes without specifying causal mechanisms. The relevant criterion depends on the task. Comparative evaluation should therefore avoid reducing adequacy to a single ranking.

Definition 22.795 (Theory domain-of-adequacy profile). *A theory domain-of-adequacy profile* records the theory, target phenomena, analytical tasks, population or institutional configuration, spatial and temporal scale, background conditions, evidential support, known successes, known failures, unresolved cases, portability conditions, and the boundaries beyond which the supported claims should be weakened or suspended.

Domain profiles can be constructed historically as well as empirically. A theory may have been developed in response to a particular monetary regime, industrial structure, welfare settlement, colonial relation, technological environment, or mode of household organization. Later application can remain productive, but comparative inquiry should determine which original conditions were incidental and which were constitutive to the mechanism. Historical reconstruction in Section 22.18 therefore contributes directly to domain specification.

Transport across domains requires additional warrant. Evidence that a mechanism operates in one labor market, platform, jurisdiction, community, or historical period does not establish that the same relation holds elsewhere. Researchers can investigate transport by comparing the mechanism's enabling conditions, measurement meanings, institutional interfaces, and relational configurations across sites. Failed transport can refine the theory even when the original domain remains intact.

Proposition 22.796 (Scoped adequacy condition). *A theory's comparative adequacy should be stated relative to a specified analytical task and supporting domain; successful explanation, prediction, interpretation, or evaluation within that domain does not by itself warrant extension to materially different scales, institutions, histories, or research purposes.*

Domain analysis can therefore convert apparent theoretical rivalry into a structured map of local strengths and limits. It can also reveal genuine overlap: two theories may each claim adequacy over the same domain while proposing incompatible mechanisms. Those cases provide especially valuable targets for the discriminating designs developed in the preceding subsection.

22.20.4 Theory Combination

Theory combination asks whether differentiated theoretical contributions can be coordinated within one research design or explanation. Chapter 21 developed multi-theoretical explanation conceptually. The research-programme task is to specify when combination is empirically, formally, historically, or interpretively warranted and how the interfaces among theories should be recorded.

Combination can occur across levels, mechanisms, timescales, or analytical functions. An institutional theory can specify rule formation while a behavioral theory models response to those rules. A macroeconomic account can identify aggregate constraints while a distributional theory studies heterogeneous incidence. A historical theory can explain path formation while a formal model studies dynamics conditional on the inherited configuration. A capability approach can contribute an evaluative object while GRE examines the relational conditions that alter future capability formation. These combinations remain useful only if their components are not silently redefined until disagreement disappears.

Definition 22.797 (Theory-combination architecture). *A theory-combination architecture specifies the research object, participating theories, contribution assigned to each theory, levels and timescales of operation, shared and theory-specific variables or concepts, interface relations, possible double counting, unresolved contradictions, evidential responsibilities, and the conditions under which one component can be revised or removed without invalidating the entire explanation.*

Combination should make explanatory division of labor explicit. If two theories both account for the same outcome through different versions of the same mechanism, adding them can duplicate rather than enrich explanation. If one mechanism changes the conditions under which another operates, the relation is interactive rather than additive. If one theory provides a normative evaluation while another provides causal explanation, their roles should remain distinguishable even when both are necessary to the research question.

Formal combination also requires care. Variables imported from one theoretical framework can lose meaning when inserted into another model. A class category, institutional rule, care relation, ecological constraint, or capability measure carries assumptions that may not survive simple parameterization. The formal research programme of Section 22.17 therefore interfaces with comparative theory through explicit semantic and structural mappings.

Proposition 22.798 (Compositional accountability condition). *A multi-theoretical explanation is comparatively warranted when the contribution, interface, evidential responsibility, and residual disagreement of each component remain identifiable, and when the combined explanation performs analytical work that cannot be obtained merely by listing the component theories side by side.*

This condition favors structured composition over eclecticism. The aim is not to maximize the number of theories represented. A smaller architecture with explicit interfaces can provide stronger comparative knowledge than a broad synthesis in which the source of each claim becomes impossible to trace.

22.20.5 Theory Conflict

Theory conflict requires a different procedure from theory combination. Two theories can conflict because they make incompatible empirical claims, specify mutually exclusive mechanisms, define the explanatory object differently, use incompatible evidential standards, or retain divergent normative or ontological commitments. Treating all conflict as if it could be resolved by additional data obscures these distinctions.

Definition 22.799 (Theory-conflict dossier). A *theory-conflict dossier* records the theories involved, focal claims, type and level of conflict, shared manifestations, incompatible propositions or commitments, evidence relevant to adjudication, translation history, scope conditions, normative premises where applicable, possible coexistence conditions, and the status assigned to the conflict after analysis.

Conflict can be typed provisionally as empirical, mechanistic, representational, methodological, historical, normative, or constitutive. The categories can overlap. An empirical conflict concerns observations or estimated relations that cannot jointly hold within the stated domain. A mechanistic conflict concerns incompatible accounts of how a pattern is produced. A representational conflict concerns units or structures that cannot be translated without material loss. A methodological conflict concerns what kinds of evidence or inference are adequate. A normative conflict concerns evaluation. A constitutive conflict persists because the theories organize the object through commitments that are not reducible to an observational disagreement.

Comparative adjudication should follow the type of conflict. Empirical conflicts can motivate new measurement or discriminating designs. Mechanistic conflicts can motivate process tracing, intervention, historical reconstruction, or simulation. Representational conflict can motivate formal comparison or a translation stopping condition. Methodological conflict can require meta-methodological analysis. Normative conflict requires explicit argument and affected-party or institutional analysis rather than an empirical tiebreaker. Constitutive conflict may need to be retained as a durable plurality.

Definition 22.800 (Conflict disposition). A *conflict disposition* is the research-programme status assigned after comparative analysis: empirically adjudicated, provisionally favored within a stated domain, decomposed into non-competing components, retained as unresolved, preserved as constitutive disagreement, or returned for further translation and evidence.

Proposition 22.801 (Conflict-method correspondence). *A theory conflict should be adjudicated only by procedures capable of addressing the kind of disagreement actually present; evidence that bears on one component of a conflict should not be used to declare resolution of distinct normative, representational, methodological, or constitutive components.*

This correspondence prevents premature theoretical victory. A model can outperform another predictively while leaving normative disagreement untouched. Historical evidence can undermine a universal mechanism claim without settling a formal equivalence question. A successful intervention can support one local causal mechanism without establishing that the theory containing it is globally superior.

22.20.6 Theory Revision

Comparison is scientifically productive when it can change the participating theories. Revision can involve narrowing a domain, modifying a mechanism, separating previously fused concepts, adding an omitted relation, changing a measurement interface, weakening a formal assumption, or abandoning a claim. GRE itself remains subject to the same revision discipline.

A research programme should distinguish revision from accommodation. Revision exposes a prior claim to change and records the consequences of that change for connected propositions. Accommodation adds auxiliary assumptions after difficulty arises while leaving the core claim insulated. Auxiliary assumptions are often legitimate, but their role should remain inspectable so that repeated adjustment does not make a theory compatible with every possible result.

Definition 22.802 (Versioned theory-revision record). A *versioned theory-revision record* specifies the prior claim or configuration, comparative evidence or argument motivating revision, affected assumptions and mechanisms, retained content, modified content, abandoned content, consequences for related claims, new domain or boundary conditions, and observations or arguments that could motivate further revision.

Revision can be local or architectural. A local revision changes one mechanism while preserving the surrounding theory. Architectural revision changes relations among major concepts or the theory's unit of analysis. Comparative inquiry should state which kind has occurred because a series of local changes can eventually alter the identity of a theoretical programme even when terminology remains stable.

Revision also has provenance. If GRE adopts a distinction exposed by feminist economics, ecological economics, institutional economics, capability theory, Marxian analysis, complexity economics, or another tradition, the comparative record should preserve that origin rather than presenting the revised GRE concept as self-generated. Provenance supports intellectual accountability and helps later researchers reconstruct why a concept entered the programme.

Proposition 22.803 (Comparison-to-revision condition). *Comparative inquiry contributes to theory revision when the observed difficulty can be localized to a claim, assumption, mechanism, representation, scope condition, or evaluative premise and when the resulting change is recorded strongly enough that later research can distinguish the revised theory from its prior version.*

Versioned revision also improves cumulative comparison. Replication and reinterpretation can test both earlier and revised formulations rather than allowing unsuccessful versions to disappear. This interface becomes important for the later replication and reinterpretation programme, where replication is treated as conceptual and historical as well as empirical.

22.20.7 Negative Translation Results

A negative translation result occurs when an attempted mapping among theories fails in a material way. Such results are especially valuable because theoretical dialogue often loses them: successful correspondences are published as syntheses, while failed mappings remain in notes or are silently reformulated until they appear to work. A cumulative programme should preserve failed translation with the same care given

to successful translation.

Failure can take several forms. A concept can lack a target counterpart with the required inferential role. A structural mapping can collapse a relation essential to the source explanation. A cross-scale translation can fail because the aggregation mechanism is unknown. A historical translation can erase sequence dependence. A normative translation can force incommensurable values into an unjustified common metric. A formal translation can introduce representation excess. A domain translation can fail because validity remains dependent on specialized knowledge that the target theory does not contain.

Definition 22.804 (Negative translation result). A *negative translation result* is a documented finding that a proposed theoretical mapping fails to preserve one or more properties material to the intended comparative claim under the specified domain, evidence, and translation procedure.

Definition 22.805 (Negative-translation ledger). A *negative-translation ledger* records the source and target theories, attempted mapping, focal claim, preservation criterion, observed failure, material remainder, consequences for comparison, translation stopping point, and conceptual, empirical, formal, or domain developments that could justify re-examination.

Negative translation is distinct from proof of permanent incommensurability. A mapping can fail because the target vocabulary is too coarse, evidence is insufficient, a required formalism does not yet exist, or the domain has been misspecified. The ledger should therefore preserve both the stopping reason and a possible re-entry condition. Some failures may remain stable; others may be reopened by new evidence or conceptual tools.

Proposition 22.806 (Negative-translation preservation condition). A *material translation failure* should remain part of the GRE comparative record when it limits equivalence, combination, transport, or inference; preserving the failure reduces repeated overtranslation and creates an explicit target for later conceptual, empirical, or formal development.

Negative results also protect source theories from assimilation. If a care relation, ecological constraint, legal status, class relation, capability concept, or historical category cannot be translated without losing a constitutive feature, the comparative programme can retain the source-language object at the interface. The absence of a GRE-equivalent term is then an informative boundary rather than a defect to be concealed.

22.20.8 Theoretical Pluralism

Theoretical pluralism is the programme-level consequence of the preceding operations. Translation can establish partial commonality, competitive comparison can discriminate among some mechanisms, domain analysis can localize adequacy, combination can coordinate differentiated contributions, conflict analysis can preserve unresolved disagreements, revision can change participating theories, and negative translation can mark legitimate stopping points. These outcomes rarely imply that one theory should absorb all others.

Pluralism requires structure. Retaining many theories without specifying their roles, overlaps, conflicts, and standards of revision can protect weak claims as easily as it protects useful diversity. Conversely, premature unification can erase his-

torically or normatively important differences. The research problem is therefore to maintain a portfolio whose plurality is itself accountable to evidence, argument, domain performance, and explicit research purposes.

Definition 22.807 (Theoretical pluralism portfolio). *A theoretical pluralism portfolio records the theories retained within a research programme, the questions and domains for which each is used, translation interfaces, known overlaps, unresolved conflicts, distinctive evidential or normative contributions, negative translation boundaries, revision history, and conditions for adding, suspending, combining, or retiring theoretical components.*

A pluralism portfolio is not a ranking table. Theories can have different kinds of adequacy that resist commensuration on one scale. A theory may contribute causal explanation, another historical reconstruction, another institutional interpretation, another normative evaluation, and another formal tractability. Comparison remains possible through task-relative criteria without creating a universal score of theoretical quality.

Pluralism also has institutional implications for research. Training, journals, datasets, model repositories, and funding structures can favor theories whose objects are already measurable or whose methods fit dominant infrastructures. A comparative programme should therefore distinguish theoretical weakness from infrastructural disadvantage. Some research objects may require new archives, relational data, historical reconstruction, participatory methods, or formal tools before their claims can be evaluated symmetrically.

The programme should nevertheless permit theory retirement. A theory or component can lose research standing when its central claims repeatedly fail within their asserted domain, when auxiliary revisions eliminate discriminating content, when another account explains the same target with fewer unsupported commitments for the same purpose, or when the object it presupposes no longer corresponds to the studied configuration. Retirement can be local rather than total: a theory may remain historically or interpretively valuable after losing one empirical claim.

Proposition 22.808 (Disciplined theoretical pluralism). *Theoretical pluralism is research-generative when retained theories have identifiable analytical roles, are exposed to task-appropriate evidence and criticism, preserve material disagreements and translation limits, and remain open to combination, revision, domain contraction, suspension, or retirement as comparative inquiry develops.*

The comparative theory programme therefore converts theoretical diversity into a cumulative research architecture. Cross-theory translation creates inspectable interfaces; competing explanations generate discriminating questions; domain profiles localize adequacy; theory combination coordinates differentiated explanatory labor; conflict dossiers match disagreements to appropriate adjudication procedures; revision records preserve conceptual change; negative-translation ledgers retain failed mappings; and pluralism portfolios govern the continued coexistence of differentiated theories.

Proposition 22.809 (Comparative-theory programme condition). *GRE develops as a comparatively accountable research programme when theoretical translation, competition, adequacy, combination, conflict, revision, and non-translation are recorded as revisable research results rather than being reduced either to theoretical unification or to unstructured coexistence.*

This architecture prepares the next stage of Chapter 22. Once theories and evidence can be compared without premature assimilation, research can move from explanatory comparison to deliberate institutional change. The following section therefore examines intervention and institutional experimentation as a programme in which causal learning, reversibility, monitoring, and ethical constraints become part of economic research design.

22.21 Intervention and Institutional Experimentation

Earlier chapters developed intervention as a mode of praxis whose design must remain historically situated, relationally explicit, revisable, monitored, and ethically bounded. Chapter 11 in particular distinguished pilot, field, natural, policy, and institutional experiments and integrated intervention with monitoring, evaluation, revision, and exit. The role of the present section is different. It converts those methodological resources into a research programme for studying interventions themselves. Its objective is to specify how pilots, naturally occurring changes, field experiments, institutional experiments, adaptive designs, reversible commitments, monitoring systems, learning processes, and ethical constraints can generate cumulative knowledge about economic mechanisms without treating practical action as a neutral data-production device. The method is intervention-based and plural: experimental and quasi-experimental designs can be combined with historical reconstruction, process tracing, institutional interpretation, relational observation, simulation, and quantitative estimation according to the research claim.

Intervention research occupies a distinctive position in GRE because practical transformation can reveal relations that remain difficult to identify under passive observation. Changing an allocation rule can expose a previously latent dependency; altering an information interface can reveal where attention or conversion capacity is constrained; changing institutional authority can disclose whether an observed pattern depends on formal rule, informal practice, or accumulated history. Yet intervention also changes the field from which evidence is drawn. It can create expectations, categories, strategic responses, new dependencies, learning, institutional memory, or irreversible residues. Evidence generated by intervention is therefore valuable precisely because it is practical, and it requires an evidential architecture that records the transformation through which it was produced.

Definition 22.810 (Intervention-research dossier). An *intervention-research dossier* records the focal research question, pre-intervention configuration, intervention or naturally occurring change, mechanism hypothesis, assignment or exposure process, affected positions, implementation history, comparison structure, monitoring architecture, intervention-generated epistemic events, intended and unintended effects, reversibility provisions, ethical constraints, decision gates, revision history, transfer conditions, and unresolved uncertainties.

The dossier links practical history to research claims. It should distinguish the intervention that was authorized from the intervention actually realized; the comparison that was planned from the comparison that remained credible after implementation; and outcomes that were merely observed after the intervention from effects for which an identification argument exists. It should also record how the intervention

Table 22.21: Principal programmes in GRE intervention and institutional experimentation

Programme	Primary research object	Research output	Principal failure risk
Pilot intervention	Bounded practical commitment	Pilot-learning profile and decision gate	Feasibility or short-run success mistaken for general efficacy
Natural experiment	Historically generated exposure contrast	Assignment reconstruction and scoped causal claim	Exogeneity inferred from the word “natural”
Field experiment	Designed variation in an operating field	Field-experiment dossier with interference and implementation record	Treatment label detached from realized practice
Institutional experiment	Change in rules, roles, authority, or routines	Institutional trajectory and mechanism record	Institution treated as a fixed treatment container
Adaptive experiment	Sequential intervention changed through incoming evidence	Versioned adaptation path and decision policy	Adaptation hidden, destroying interpretability of exposure histories
Reversible experiment	Intervention with planned rollback or repair	Reversibility profile and residual-effect ledger	Administrative rollback mistaken for restoration of the prior field
Monitoring	Observation and feedback during intervention	Monitoring ledger and warning architecture	Indicators becoming unrecorded interventions or optimization targets
Learning	Revision induced by intervention-generated evidence	Versioned learning and revision record	“Learning” asserted without an identifiable change in belief, design, or institution
Ethical constraint	Boundary on admissible exposure and learning	Ethical intervention envelope	Epistemic value used to override standing, rights, burden, or future agency

changes future research conditions. A pilot that builds new organizational capacity, a public experiment that changes expectations, or a field trial that teaches participants how to respond can alter the baseline for every later stage.

Table 22.21 summarizes the principal intervention-research programmes developed below.

22.21.1 Pilot Interventions

Pilot interventions provide a natural entry point because they deliberately restrict practical commitment while allowing mechanisms and implementation conditions to

encounter the field. Their research value, however, does not lie simply in being small. A pilot can be geographically narrow yet institutionally deep, temporally brief yet historically consequential, or limited in participant number while creating a durable classification or precedent. Research on pilots should therefore study the dimensions along which boundedness is actually achieved and the dimensions along which consequences may exceed the nominal pilot envelope.

The first question is what the pilot is designed to learn. Feasibility, mechanism operation, implementation capacity, observation quality, participant response, burden distribution, institutional adaptation, and rollback capacity are distinct research targets. A pilot designed to determine whether an organization can implement a new allocation procedure need not identify the long-run effect of that procedure on generative opportunity. A pilot designed to test a mechanism can succeed epistemically even when the programme is not suitable for scale-up. Conversely, smooth implementation can coexist with absence of the proposed mechanism.

Definition 22.811 (Pilot-learning profile). A *pilot-learning profile* records the pilot envelope, questions assigned to the pilot, mechanisms exposed to practical test, enabling conditions, realized implementation, affected positions, evidence generated, deviations from design, adverse and distributional effects, reversibility status, uncertainties reduced, uncertainties created, and the decision options supported after the pilot.

Pilot research should preserve selection into the pilot. Early sites are often unusually motivated, well resourced, administratively capable, or closely supported. Participants can be selected because they are reachable or willing. These conditions may be part of the mechanism rather than incidental noise. The research dossier should therefore record what is exceptional about the pilot field and whether those features are expected to exist elsewhere.

Pilots also generate historical effects that alter later inference. Organizations learn procedures; participants change expectations; complementary infrastructure can be built; public attention can intensify; opponents can organize; and the intervention can acquire legitimacy or stigma. The post-pilot field is consequently not the original field plus new information. It is a modified configuration. Later comparison and scaling should incorporate that transformation.

Proposition 22.812 (Pilot inference boundary). *Evidence from a pilot warrants claims only about the practical and epistemic questions for which the pilot provides an adequate exposure, comparison, observation, and mechanism test; successful bounded implementation does not by itself warrant claims of wider efficacy, durability, justice, or generative benefit.*

This boundary permits pilots to remain valuable even when their proper conclusion is “continue learning,” “modify,” or “stop.” A research programme should therefore preserve pilots that reveal mechanism failure, unanticipated burden, excessive monitoring cost, or insufficient reversibility rather than treating only expansion decisions as successful experimental outcomes.

22.21.2 Natural Experiments

Natural experiments occupy an unusual place in an intervention programme because the focal variation is not designed by the researcher. A law changes at one boundary and not another; an administrative rule is phased in unevenly; a shock affects access

to an institution; a threshold assigns different treatment; or a historically contingent event creates groups with different exposure. Such variation can support stronger causal inference when the assignment process approximates conditions under which alternative explanations can be bounded. The practical transformation nevertheless remains a real intervention in the lives and institutions being studied, even when the researcher did not authorize it.

Section 22.19 treated quasi-experimental and causal-inference designs in the quantitative programme. The present concern is the broader intervention history surrounding the contrast. Researchers should reconstruct who created the variation, why it occurred, which positions anticipated it, whether actors could sort around it, what other institutional changes accompanied it, and how the event altered later behavior and observability. The identifying contrast can be statistically credible while the substantive interpretation remains wrong if the institutional history is misdescribed.

Definition 22.813 (Natural-experiment assignment reconstruction). A *natural-experiment assignment reconstruction* records the process generating differential exposure, relevant timing and thresholds, actors capable of anticipating or manipulating assignment, co-occurring institutional changes, pre-exposure differences, spillovers, implementation variation, measurement changes, and the assumptions connecting the historical contrast to a causal estimand.

The word *natural* should therefore carry no presumption of exogeneity. Some apparently external shocks are responses to prior local conditions; administrative boundaries can coincide with long histories of segregation or institutional difference; policy timing can respond to expected outcomes; and affected agents can adapt before formal implementation. Historical and institutional reconstruction from Section 22.18 can be essential to deciding whether a quantitative design is credible.

Natural experiments can also reveal institutional heterogeneity. The same formal policy change can be implemented differently across organizations, professions, regions, or networks. Rather than treating this heterogeneity solely as a threat to identification, GRE research can investigate it as evidence about mediation, conversion, relational structure, and institutional capacity.

Proposition 22.814 (Natural-experiment warrant). *A naturally occurring contrast supports an intervention-relevant causal claim only when the exposure-generating history, anticipation and sorting possibilities, concurrent changes, spillovers, implementation differences, and measurement conditions are sufficiently reconstructed for the identifying assumptions to remain defensible within the stated domain.*

A natural experiment can thus produce both a causal estimate and a history of institutional transformation. The two outputs should remain connected: the estimate states what the comparison can identify, while the reconstruction explains what kind of intervention the comparison actually represents.

22.21.3 Field Experiments

Field experiments introduce designed variation within operating economic and institutional environments. Their attraction is direct contact with real implementation conditions. Their difficulty is that those conditions are relational: participants interact, organizations adapt, treatment can spill across network ties, providers exercise discretion, and observation itself can influence behavior. A field experiment should

therefore be represented as a realized intervention history rather than as a treatment label attached to subjects.

Definition 22.815 (Field-experiment dossier). A *field-experiment dossier* records the assignment mechanism, intended treatment, realized treatment components, implementation agents, participant and nonparticipant relations, interference pathways, compliance and substitution, observation effects, contextual events, attrition and missingness, outcome manifestations, mechanism evidence, adverse effects, and the inferential scope of the resulting estimates.

Interference is especially important for relational economics. One participant's treatment can change another participant's opportunity, price, workload, information, or network position. A training programme can affect untreated coworkers; a platform rule can alter market conditions for all sellers; a resource transfer can change household bargaining or local prices. Standard individual-level treatment-control reasoning may therefore estimate an effect that is conditional on a particular saturation level rather than an invariant treatment effect.

Implementation should also be disaggregated. If local staff interpret rules differently, if participants access only some components, or if complementary resources vary, the experiment can contain several substantively different interventions. Researchers should decide whether these variations are implementation failures, treatment heterogeneity, or mechanisms of interest. The decision affects both causal interpretation and transfer.

Field experiments can generate strong local evidence while remaining narrow in time. A measured productivity increase, behavioral change, or access effect does not automatically establish a durable change in capability, relation, institutional reproduction, or future option space. The generative causal escalation discipline developed in Section 22.19 therefore applies directly.

Proposition 22.816 (Field-interference condition). *Field-experimental inference should represent interference, substitution, institutional response, and treatment realization whenever these processes can materially alter exposure or outcomes; an individual assignment indicator is not an adequate representation of the intervention when the mechanism operates through a shared relational field.*

This condition does not require maximal complexity. It requires the comparison unit to match the mechanism. Some studies can remain individual; others require household, team, network, institution, market, or multi-level representations.

22.21.4 Institutional Experiments

Institutional experiments modify rules, authority, roles, procedures, rights, obligations, participation channels, information architectures, or resource-governance arrangements. Their research object is therefore larger than a policy input. The institution can reinterpret the intervention, generate new routines, redistribute discretion, change membership boundaries, and create path-dependent expectations. The experiment acts on a structure that also acts back on the experiment.

Institutional experiments can be deliberately designed, as in a new governance rule or participatory budgeting process, or emerge through decentralized variation across organizations. Their evaluation should reconstruct both formal change and enacted institution. A rule written in policy text can remain weakly realized; an infor-

mal practice can become more consequential than the formal reform; or temporary discretion can become normalized after the experimental period.

Definition 22.817 (Institutional-experiment trajectory). *An institutional-experiment trajectory is a time-indexed record of the pre-existing institutional configuration, authorized change, enacted rules and practices, role and authority redistribution, compliance and contestation, informal adaptation, resource and information effects, membership consequences, emergent routines, persistence or reversal, and the mechanisms proposed to connect these changes to observed outcomes.*

Institutional identity should be versioned. If the experiment changes who participates, how authority is exercised, or what organizational purpose actors pursue, the institution observed later may not be the same analytical object as the institution observed before intervention. Longitudinal research should therefore preserve continuity claims rather than rely only on an unchanged organization name.

Institutional experimentation also provides a direct test of relational mechanisms. If changing decision rights alters resource flow but not participation, the result can distinguish authority from nominal inclusion. If changing ownership leaves effective control unchanged, formal legal change and operative power should be separated. If a new return mechanism improves local maintenance but creates new gatekeeping, the experiment can expose coupled generative and power effects.

Proposition 22.818 (Institutional-mechanism identification). *An institutional experiment supports a mechanism claim when the relevant change in rules, roles, authority, routines, or participation is shown to have been enacted, the institutional adaptations mediating its effects are traced, and plausible concurrent mechanisms are sufficiently distinguished for the stated inference.*

The proposition preserves institutional experimentation as more than before-and-after outcome comparison. The institution is both intervention object and mediator, so its internal transformation belongs inside the evidence.

22.21.5 Adaptive Experiments

Adaptive experiments change intervention parameters, allocation, sampling, eligibility, intensity, monitoring, or implementation as evidence accumulates. Adaptation can reduce avoidable harm and direct resources toward more informative or promising branches. It can also make the experimental history difficult to interpret because later exposure depends on earlier outcomes, model updates, institutional judgments, or participant responses.

The research programme should therefore distinguish adaptive experimentation from undocumented mid-course adjustment. Adaptation should have a versioned decision rule: what information can trigger change, who is authorized to decide, which components can change, what protections constrain adaptation, and how the changed design alters inference. A rigid pre-specification is not always desirable, but unrecorded flexibility makes it impossible to reconstruct what intervention was tested.

Definition 22.819 (Adaptive-experiment protocol). *An adaptive-experiment protocol specifies the intervention components eligible for revision, information used for adaptation, decision thresholds or judgment procedures, authorized decision makers, update timing, protected constraints, versioning requirements, inferential*

adjustments, and stopping, branching, or rollback conditions.

Adaptive research can pursue several goals. *Safety adaptation* reduces exposure after warning signals. *Learning adaptation* directs observation toward unresolved mechanisms. *Implementation adaptation* changes procedures when the original design is infeasible. *Allocation adaptation* changes assignment probabilities or resource intensity. *Institutional adaptation* modifies governance or responsibility as new affected positions become visible. These goals can conflict; maximizing short-run outcome can reduce the variation needed for learning, while maximizing information can impose unnecessary exposure.

Adaptation also makes the intervention endogenous to its own evidence. An observed improvement after three revisions cannot be attributed to the original treatment specification. The research object is the sequence of versions and decision rules. Methods appropriate to sequential designs, dynamic treatment regimes, process tracing, or simulation can be used where their assumptions fit, but the version history remains the common evidential substrate.

Proposition 22.820 (Adaptive interpretability condition). *An adaptive experiment remains interpretable when the information-to-revision pathway, successive intervention versions, changing exposure probabilities or eligibility, protected constraints, and inferential consequences are recorded well enough to reconstruct which histories generated the observed evidence.*

This condition permits genuine learning during experimentation without pretending that a changing intervention is a stable treatment. It also allows negative adaptation histories, such as repeated failure to find an acceptable version, to enter the programme as evidence.

22.21.6 Reversible Experiments

Reversibility is valuable because it preserves correction capacity when evidence remains incomplete. It should nevertheless be studied rather than assumed. Turning off a software system, ending a subsidy, revoking a temporary rule, or restoring an earlier organizational chart can be administratively simple while leaving knowledge, expectations, investments, classifications, ecological effects, trust changes, or dependency patterns behind.

Research on reversible experiments should therefore distinguish formal rollback from substantive recovery. The relevant question is not whether an intervention can be discontinued but which dimensions of the pre-intervention field can be restored, which can be repaired, which have changed irreversibly, and which new capacities should deliberately be retained.

Definition 22.821 (Experimental reversibility profile). *An experimental reversibility profile* records the intervention components subject to rollback, resources and authority required for reversal, temporal window for effective rollback, dependencies created during intervention, recoverable and non-recoverable state variables, residual institutional and relational effects, repair obligations, preserved beneficial capacities, and evidence needed to judge whether rollback has succeeded.

Reversibility can be asymmetric across affected positions. An organization may restore its previous procedure while participants cannot recover lost time or privacy. A temporary market rule may be withdrawn while firms that exited cannot readily

re-enter. An experimental data architecture may be dismantled while information already disclosed cannot be made unknown. The profile should therefore be position-specific rather than defined from the implementer's perspective alone.

Reversal itself can generate evidence. Failure to recover the prior relation can reveal hysteresis, lock-in, institutional memory, sunk capability loss, or dependency. Successful rollback can show that a mechanism depends on continued support rather than permanent transformation. Researchers should design post-reversal observation where these questions matter.

Proposition 22.822 (Reversibility warrant). *An experiment should be described as reversible only with respect to specified dimensions and affected positions for which rollback, recovery, or repair is operationally available; administrative termination alone does not establish restoration of the prior relational or generative configuration.*

Reversibility is thus both a protective resource and a research object. It can justify deeper practical contact in some settings while simultaneously exposing which changes become historically sticky.

22.21.7 Monitoring

Monitoring links intervention to ongoing evidence. Chapter 11 already developed monitoring as part of recursive praxis. Within the research programme, the key question is how monitoring data should be designed, interpreted, and archived so that they reveal intervention dynamics without being mistaken for passive measurement.

A monitoring architecture can contain implementation indicators, immediate outcomes, relational indicators, capacity and constraint measures, distributional effects, adverse-event signals, power and participation indicators, environmental or infrastructural conditions, and longer-horizon generative manifestations. The appropriate set depends on the mechanism and ethical stakes. High-frequency observation is useful when rapid harm requires response; it can be counterproductive when it imposes surveillance burden, generates noise, or encourages optimization around visible metrics.

Definition 22.823 (Intervention-monitoring ledger). *An intervention-monitoring ledger is a time-indexed record of monitored constructs and manifestations, data provenance, observation cadence, responsible positions, missingness and uncertainty, warning thresholds, implementation versions, intervention-generated changes in measurement, observer effects, feedback actions, and the research or practical decisions triggered by monitoring results.*

Monitoring can become an intervention through disclosure, classification, ranking, alerting, or repeated attention. Participants can change behavior because they know what is measured; organizations can optimize visible indicators; public dashboards can redistribute reputational pressure; risk scores can alter access. The ledger should record these feedback channels rather than treating them as contamination external to the study.

Monitoring systems should also retain exception paths. Aggregation can conceal a small group experiencing severe harm, a mechanism operating only in a specific relational position, or a rare event that reveals an invalid assumption. A research programme centered on generativity and heterogeneous subjects has reason to preserve such cases even when they do not materially move an aggregate estimate.

Proposition 22.824 (Monitoring-feedback condition). *Monitoring evidence should be interpreted jointly with the feedback actions, behavioral responses, classification effects, and intervention revisions that the monitoring system produces whenever those processes can alter the field being observed.*

The proposition is especially important for adaptive experiments. Once a signal changes allocation or implementation, the later data belong to a different experimental history. Monitoring and adaptation must therefore share a common version record.

22.21.8 Learning

Intervention becomes research when generated evidence can alter understanding in a traceable way. “Learning” should therefore designate a change in the research or practical configuration rather than the mere accumulation of observations. An intervention can change a mechanism hypothesis, narrow an estimated domain, reveal an omitted affected position, revise a measurement instrument, expose an ethical problem, alter an institutional design, or show that the original research question was mis-specified.

Learning can be separated provisionally into several forms. *Mechanism learning* changes beliefs about how effects are produced. *Implementation learning* changes understanding of what is required to enact the intervention. *Institutional learning* changes rules, roles, routines, or organizational memory. *Measurement learning* changes what is observed or how manifestations are interpreted. *Normative learning* changes the recognized interests, burdens, values, or standing relevant to evaluation. *Transfer learning* changes beliefs about where results can travel. These forms can reinforce or conflict with one another.

Definition 22.825 (Intervention-learning record). An *intervention-learning record* specifies the prior claim, expectation, design, or institutional configuration; the intervention-generated evidence bearing on it; the inferential route from evidence to proposed revision; disagreement and residual uncertainty; the resulting change in mechanism, model, design, measurement, institution, ethical constraint, or domain claim; and the observations that could reopen the revision.

A learning record prevents retrospective smoothness. Research teams often describe the final intervention as if its design were obvious from the beginning, erasing abandoned mechanisms, failed measures, contested interpretations, and protective changes. Versioned learning preserves these paths as part of the evidence base and makes later replication or reinterpretation possible.

Learning should also be separated from optimization. An adaptive system can improve a chosen performance metric while reducing understanding of why the improvement occurred or whether other values deteriorated. Conversely, an experiment can generate strong learning even when it does not improve the target outcome. The research programme should therefore record both practical performance and epistemic yield.

Proposition 22.826 (Learning-to-revision condition). *Intervention-generated evidence counts as programme-level learning when it produces a traceable revision, confirmation with narrowed uncertainty, domain restriction, protected non-revision, or newly specified open question whose relation to the prior research state is explicitly recorded.*

This condition makes non-revision legitimate. Evidence can support retaining a prior mechanism or institution, provided the relevant test was capable of changing that conclusion. Learning is not synonymous with novelty.

22.21.9 Ethical Constraints

Ethical constraints bound intervention research because the production of knowledge can expose subjects, communities, institutions, and future positions to burdens that are not reducible to statistical risk. Interventions can affect rights, standing, privacy, livelihood, recognition, authority, dependency, option space, ecological conditions, or intergenerational possibilities. Ethical architecture therefore belongs to research design, not to a final compliance step added after the intervention has been optimized for identification.

Relevant questions include who has authority to initiate the experiment, whose consent or authorization is required, which interests cannot be traded for information gain, how burdens and benefits are distributed, whether participation and contestation are meaningful, what data are collected, which groups bear concentrated uncertainty, what remedy is available after harm, and which future options can be foreclosed. Individual consent can be necessary without being sufficient where institutional changes impose spillovers on nonparticipants or alter shared resources.

Definition 22.827 (Ethical intervention envelope). An *ethical intervention envelope* specifies the admissible forms and limits of experimental exposure given affected positions, legitimate authority, consent or other authorization, protected rights and standing, burden distribution, uncertainty, available alternatives, reversibility, data and monitoring practices, participation and contestation, remedy, stopping rules, and effects on future agency and shared conditions.

The envelope should be versioned as the experiment changes. A low-risk pilot can become ethically different when scaled, when monitoring becomes more intrusive, when participation becomes effectively compulsory, or when a temporary rule becomes institutionally durable. New affected positions can also appear after implementation. Ethical review should therefore be capable of reopening rather than functioning as a one-time authorization.

Ethical constraints can also affect inferential design. A comparison group may be inadmissible when withholding an established protection would impose serious avoidable harm. Randomization may be unacceptable when legitimate claims require priority. Conversely, immediate universal rollout can be ethically problematic when uncertainty is large, potential harm is substantial, and staged implementation with safeguards could preserve both protection and learning. The correct design cannot be derived from identification strength alone.

Proposition 22.828 (Ethical non-substitutability). *Greater expected information, statistical power, implementation efficiency, or policy importance does not by itself compensate for violations of protected standing, unjustified exposure, illegitimate authority, unavailable remedy, or material foreclosure of future agency; these constraints require explicit substantive justification rather than absorption into a single epistemic benefit-risk score.*

The principle is intentionally non-scalar. Ethical reasoning can involve trade-offs, thresholds, duties, priorities, and plural values that should remain visible rather than compressed into one optimization target. This is consistent with the justice and

heterogeneous-value research programmes developed earlier in the chapter.

The nine programmes can now be integrated without treating intervention as a privileged source of truth. Interventions can reveal causal and institutional structure, but they can also produce the very phenomena they later measure. Their research value depends on a documented relation among design, realized history, comparison, monitoring, ethical boundaries, and revision.

Definition 22.829 (Intervention research portfolio). An *intervention research portfolio* is a coordinated set of pilot, natural, field, institutional, adaptive, and reversible studies linked through shared or explicitly translated research questions, versioned intervention histories, monitoring and ethical architectures, negative and unintended results, replication or transfer attempts, and cumulative revision of mechanisms, institutions, and domain claims.

Proposition 22.830 (Intervention-to-programme condition). *Intervention contributes to a cumulative GRE research programme when the practical transformation that generated evidence remains reconstructible, inferential claims remain proportionate to the comparison and mechanism evidence, ethical and monitoring effects are preserved as part of the history, and later studies can reuse, challenge, reinterpret, or revise the resulting intervention record.*

This condition closes the intervention block by returning practical experimentation to the book's broader commitment to answerability. An intervention can be valuable because it succeeds, because it fails, because it reveals an omitted mechanism, because rollback proves incomplete, because monitoring changes behavior, or because ethical constraints show that a theoretically informative design should not be conducted. The next research tasks therefore concern the measurement problems through which such findings are represented and the counterevidence through which they remain contestable.

22.22 Measurement Problems

The role of this section is to identify the measurement problems that arise when the GRE research programme converts relational, generative, value-bearing, historical, power-relevant, and justice-relevant configurations into indicators, categories, scores, comparisons, or model inputs. Earlier chapters developed general principles of relational measurement, valuation, research design, and empirical inference. Sections 22.3–22.21 then specified research programmes for the substantive and methodological objects of GRE. The present objective is narrower and more demanding: to determine when a measure preserves enough of the target structure to support the intended claim, when comparability fails, what remains unmeasured, and how the measurement process can alter the configuration it is intended to describe.

The section proceeds through relational measurement, generativity measurement, value measurement, conversion measurement, option-space measurement, historical measurement, power measurement, justice indicators, and measurement-induced distortion. These problems share a common architecture. A GRE construct is rarely observed directly. Researchers encounter manifestations, records, classifications, behaviors, institutional traces, reported experiences, or model-derived quantities. Those manifestations are transformed into measures under a boundary, scale, time horizon, coding rule, aggregation procedure, and comparison regime. Each trans-

Table 22.22: Principal measurement problems in the GRE research programme

Measurement domain	Characteristic object	Principal measurement burden
Relational measurement	Directed, reciprocal, multiplex, higher-order, and institutional relations	Preserve position, direction, configuration, scale, and perspective rather than reducing relations to isolated attributes
Generativity measurement	Capacity to produce later capabilities, relations, values, knowledge, or options	Distinguish realized output from latent or conditional generative capacity and specify horizon and enabling conditions
Value measurement	Heterogeneous and sometimes partially commensurable value forms	Preserve value type, standpoint, recognition regime, residual loss, and limits of aggregation
Conversion measurement	Typed transformation between value forms or states	Specify source and target units, interface conditions, losses, irreversibility, selection, and context dependence
Option-space measurement	Feasible, accessible, actionable, and revisable possibilities	Distinguish nominal options from effective options and avoid treating option counts as sufficient measures of freedom or capacity
Historical measurement	Historically changing categories, records, institutions, and measurement regimes	Reconstruct category drift, selective survival, changing baselines, and time-specific meaning
Power measurement	Mechanism-specific conditioning of alternatives, dependence, and action	Measure carrier, mechanism, affected position, alternatives, persistence, and latent as well as manifested power
Justice indicators	Empirical manifestations interpreted through explicit normative premises	Keep normative rule, affected position, distribution, threshold, relation, history, and uncertainty visible
Measurement-induced distortion	Behavioral, institutional, and epistemic responses to measurement	Trace reactivity, gaming, classification effects, burden, visibility shifts, and feedback from metrics into the measured field

formation can preserve some structure while losing other structure. Measurement therefore concerns both numerical or categorical construction and the provenance of the inferential bridge connecting the resulting representation to the target claim.

Definition 22.831 (GRE measurement dossier). *A GRE measurement dossier records the target construct, unit or configuration being measured, relevant manifestations, observation and coding rules, temporal and spatial boundaries, scale, aggregation or comparison procedure, uncertainty, missingness, known omitted dimensions, invariance assumptions, alternative interpretations, downstream uses of the measure, and conditions under which the measure should be revised, disaggregated, or withdrawn.*

Definition 22.831 treats a measure as a versioned research object rather than a transparent window onto the economy. The same recorded quantity can support different claims when its construct, boundary, or comparison regime changes. Conversely, the same GRE construct can require different measures across domains because its manifestations and access conditions differ.

Proposition 22.832 (Measurement-provenance condition). *A GRE measure provides stronger warrant when the transformation from target construct through observable manifestation to indicator, category, score, or comparison remains reconstructible and when material losses introduced by that transformation are explicitly recorded.*

Table 22.22 summarizes the principal measurement problems developed below.

22.22.1 Relational Measurement

Relational measurement in GRE begins from an object that can be directed, reciprocal, multiplex, higher-order, nested, historically changing, and differently manifested from different positions. Chapter 7 developed the general methodology for measuring relations. The present research problem is how to preserve those properties when re-

lational measures are used across the substantive GRE programmes. A dyadic transaction count, network edge, contractual category, co-membership indicator, or reported dependence score can each be useful while representing only part of a relation.

A first problem is unit definition. The relevant unit can be a directed tie, a reciprocal relation, a triad, a household arrangement, an organizational role structure, a platform-mediated interaction, a legal relation, or a higher-order configuration. Converting each of these into independent individual attributes can destroy the dependence that makes the object relational. A second problem is perspective. Two positions can experience the same relation differently because access, dependence, risk, authority, and exit costs are asymmetric. Averaging those perspectives can erase precisely the asymmetry under investigation.

A third problem concerns multiplexity. One pair of positions can simultaneously be connected through employment, credit, kinship, care, data extraction, legal authority, or knowledge dependence. A single edge weight cannot be assumed to represent the combined relation. Similarly, a stable recorded tie can mask changing meaning: repeated transactions can move from voluntary exchange to lock-in, or a continuing institutional membership can persist while participation becomes less effective.

Definition 22.833 (Relational measurement preservation profile). *A relational measurement preservation profile records the focal positions, relation type or types, directionality, reciprocity, higher-order membership, relevant perspectives, temporal identity rule, scale, institutional embedding, manifestations used for measurement, and relational properties lost or compressed by the chosen representation.*

The profile supports explicit decisions about simplification. A binary edge can be adequate for one question and inadequate for another. If the research question concerns whether a contractual relation exists, binary coding may suffice. If it concerns dependence, bargaining asymmetry, or generative return, the same coding can become materially incomplete.

Proposition 22.834 (Relational non-reducibility condition). *A relational measure should not be interpreted as an individual attribute when the claim depends materially on direction, reciprocal dependence, higher-order configuration, institutional position, or another property that is lost by individualization.*

Relational measurement therefore requires question-specific preservation rather than maximal complexity. The objective is not to reproduce the entire economic configuration in every dataset. It is to retain the structure needed for the claim and to record the remainder that the chosen measure leaves outside analysis.

22.22.2 Generativity Measurement

Generativity creates a different measurement problem because the target concerns the capacity of a configuration to produce later capabilities, relations, values, knowledge, institutional forms, or options. Realized output is evidence about generativity only under specified conditions. A research programme that counts publications, firms, patents, income, trained persons, new organizations, or subsequent transactions can identify realized manifestations while still missing unused capacity, suppressed possibilities, delayed effects, fragile enabling conditions, or forms of generation that appear outside the principal metric.

The first requirement is to separate *realized generation* from *generative capacity*. A

school can produce high measured test performance while weakening curiosity or future learning capacity. A research institution can produce many papers while losing mentorship, infrastructure, or epistemic orientation. A platform can generate transaction volume while narrowing participant alternatives. Conversely, a configuration can build capability that is not immediately realized because opportunities, complementary resources, or historical conditions have not yet allowed expression.

The second requirement is a horizon. Generativity measured over weeks can differ from generativity measured over years. Short-run output can consume maintenance capacity or ecological conditions that support later production. Delayed generation can also appear after a long period of apparent inactivity. Measures should therefore identify the horizon over which downstream consequences are expected to become observable.

Definition 22.835 (Generativity measurement profile). *A generativity measurement profile records the source configuration, candidate generated objects or capacities, enabling conditions, realized manifestations, unrealized but evidenced capacities where defensible, temporal horizon, maintenance requirements, downstream option changes, persistence, spillovers, source-side depletion or regeneration, and uncertainty concerning unobserved or delayed generation.*

This profile discourages the construction of a universal generativity score. Different research objects can generate different kinds of later possibility, and the evidential access to those possibilities varies. In some studies, a multidimensional panel can be justified. In others, process tracing, historical reconstruction, or qualitative evidence can provide stronger support than a composite index.

Proposition 22.836 (Realization–capacity separation). *Observed downstream output is evidence of realized generation but does not by itself identify the full generative capacity of a relation or configuration; claims about capacity require additional evidence concerning enabling conditions, available pathways, constraints, persistence, and the horizon over which realization is possible.*

The converse also holds. Claims of latent generative capacity should not become a residual explanation for missing outcomes. Evidence for unrealized capacity requires identifiable capabilities, relations, resources, or mechanisms whose expression is blocked or deferred under specified conditions. Generativity measurement should therefore remain answerable both to realized consequences and to the evidential burden of claims about possibility.

22.22.3 Value Measurement

Value measurement is difficult because GRE treats value as heterogeneous, historically formed, relationally recognized, and only sometimes commensurable. Section 22.5 developed the research programme for heterogeneous value, while Chapter 14 distinguished valuation from measurement. The measurement problem here concerns how a value form becomes represented without assuming that the chosen unit exhausts its meaning or that a locally useful equivalence produces universal commensurability.

Monetary price can be an important measure of exchange conditions while remaining an incomplete measure of care, ecological integrity, institutional trust, epistemic quality, community continuity, legal standing, cultural meaning, or future option preservation. Survey scales can record experienced value while remaining sensitive

to framing, language, reference groups, and institutional expectations. Administrative categories can make some contributions visible while leaving informal maintenance, unpaid work, or nonrecognized knowledge outside the recorded economy.

Definition 22.837 (Value-measurement specification). A *value-measurement specification* records the value form under study, the standpoint or recognition regime through which it becomes legible, the manifestations being measured, measurement unit or category, comparison rule, aggregation rule where any, temporal horizon, residual value left outside the measure, contested interpretations, and conditions under which the measure is locally rather than generally valid.

The specification supports partial comparability. Two educational programmes, for example, can be compared on cost, completion, learning, accessibility, or later capability without requiring those dimensions to be aggregated into a single scalar. A policy decision can still require judgment, but the measurement architecture need not manufacture a common unit merely to simplify the decision.

Proposition 22.838 (Value-measurement plurality). *Where materially relevant value forms lack a justified common metric, stronger GRE measurement preserves separate measures, partial orderings, thresholds, or domain-specific comparisons rather than treating aggregation itself as evidence of commensurability.*

The measurement problem is also political and institutional. Recognition regimes determine which values acquire records, prices, credentials, ratings, legal categories, or budget lines. A value can become economically consequential through measurement because measured forms gain administrative visibility and allocation priority. This issue becomes explicit in Subsection 22.22.9, where the act of measurement is treated as a possible source of distortion and field transformation.

22.22.4 Conversion Measurement

Conversion measurement concerns transformations between typed value forms, capabilities, resources, institutional states, or other economically relevant objects. A conversion rate appears simple only when the source and target units are stable, the interface is known, and loss or delay is negligible. GRE cases often violate these conditions. Education can convert time and resources into knowledge, credentials, networks, or capability; care can convert labor and attention into maintenance, recovery, security, or future capacity; research can convert funding and infrastructure into findings, skills, reputational capital, and later options. These outputs are heterogeneous and can arrive on different timescales.

A measured conversion therefore needs a typed source and target. The numerator and denominator cannot be interpreted before the research record states what is being transformed into what. The same source quantity can produce several outputs, while the same output can depend on several complementary inputs. Selection also matters: observed conversion among participants can differ from conversion among all eligible positions when entry itself depends on prior capability or institutional access.

Definition 22.839 (Conversion measurement ledger). A *conversion measurement ledger* records source and target value or state types, units and manifestations, interface conditions, complementary inputs, eligibility and selection, temporal delay, conversion path, losses and residuals, reversibility, uncertainty, and changes in the conversion regime across positions or periods.

The ledger is especially important when researchers compare conversion efficiency across groups. A lower observed conversion can arise from different starting conditions, unequal complementary resources, institutional barriers, measurement error, delayed realization, or genuine differences in the local transformation process. A single rate can therefore confound the conversion mechanism with the conditions under which it operates.

Proposition 22.840 (Contextual conversion-rate condition). *A measured conversion rate is interpretable as a property of a conversion process only to the extent that materially relevant source composition, complementary conditions, selection, temporal horizon, and target meaning are sufficiently specified or modeled for the intended comparison.*

Conversion measurement should also preserve failed and incomplete conversion. A credential that does not produce recognized access, a payment that does not compensate for relational loss, or a knowledge product that cannot be mobilized can be analytically important outcomes rather than missing observations. The residuals help distinguish conversion failure from low measured quantity.

22.22.5 Option-Space Measurement

GRE repeatedly refers to future options, option preservation, foreclosure, revisability, and generative opportunity. These ideas create a measurement problem because an option is not equivalent to an item on a menu. An option can be formally available but practically inaccessible, technically feasible but institutionally prohibited, economically affordable but relationally costly, or legally permitted but dependent on information and capability that a position does not possess.

Counting nominal alternatives can therefore overstate effective option space. The opposite problem also occurs: a small number of high-quality, durable, and revisable options can provide greater practical possibility than a large number of nominal alternatives that are costly, fragile, or mutually redundant. Options also have dependencies. One option can unlock later options; another can consume resources or commitments that close future branches.

Definition 22.841 (Effective option-space profile). *An effective option-space profile records the focal position, candidate options, formal availability, practical accessibility, required capabilities and resources, information conditions, institutional permissions, expected costs and risks, relational dependencies, reversibility, time sensitivity, downstream options opened or closed, and uncertainty concerning feasibility.*

This profile turns option-space measurement into a structured representation rather than a simple count. Depending on the research question, useful measures can include minimum access thresholds, reachability under specified constraints, diversity of feasible pathways, switching costs, reversibility, robustness to shocks, or the presence of protected fallback options. None should automatically be interpreted as a complete measure of freedom or capability.

Proposition 22.842 (Option-count insufficiency). *The cardinality of a nominal option set is insufficient to measure effective option space when accessibility, capability requirements, dependence, reversibility, timing, or downstream foreclosure materially differ across the listed options.*

Longitudinal option-space research should also distinguish lost options from trans-

formed options. An option can disappear because an institution closes, because a skill becomes obsolete, because a relation ends, because environmental conditions change, or because a new pathway makes the old one irrelevant. These processes have different implications for generative capacity and justice even when the numerical option count changes by the same amount.

22.22.6 Historical Measurement

Historical measurement confronts changing categories, institutions, technologies, records, and measurement regimes. A variable observed in two periods can carry the same label while referring to different practices. Employment, household, literacy, disability, platform work, research output, care, ownership, poverty, and many other categories can change through law, administration, culture, technology, or statistical practice. Apparent temporal continuity can therefore be partly produced by retrospective harmonization.

Historical comparison also inherits selective survival. Some transactions produce durable records while informal relations disappear from archives. Institutions preserve what they had reasons and capacities to document. Later digitization can amplify this asymmetry by making already recorded activity easier to analyze while leaving unrecorded activity even less visible in relative terms. Missing historical data are therefore often structured rather than random.

Definition 22.843 (Historical comparability dossier). A *historical comparability dossier* records the measured construct, period-specific categories and definitions, source institutions, recording practices, coverage, known exclusions, classification changes, surviving evidence, harmonization procedures, price or quantity normalization where relevant, changing measurement technologies, and the remaining limits on temporal comparison.

The dossier makes it possible to separate several forms of apparent change. A measured increase can reflect a real change in the target configuration, expanded recording coverage, reclassification, altered recognition, changed reporting incentives, or a new measurement technology. Historical research should attempt to localize these possibilities rather than treating the time series as self-interpreting.

Proposition 22.844 (Historical invariance burden). A *longitudinal comparison requires evidence that the measure preserves sufficient meaning across the compared periods, or an explicit translation showing how changing categories, recording practices, and institutional contexts are mapped into a common analytical object.*

Historical measurement can also reveal generation rather than merely obstruct it. The emergence of a new category, index, registry, credential, or statistical unit can be evidence of changing economic relations and institutions. The measurement regime itself can therefore become part of the historical object, especially when new forms of legibility change allocation, governance, or recognition.

22.22.7 Power Measurement

Power measurement is particularly vulnerable to scalar simplification. Section 22.11 defined economic power as a family of mechanism-specific research objects involving resources, capabilities, relations, institutions, knowledge, conversion, circulation,

capture, and persistent asymmetry. These forms do not automatically share a common unit, and observable exercise of power is not identical to possession of power-relevant capacity.

A position can influence outcomes without issuing visible commands because alternatives are already structured by dependence, gatekeeping, agenda control, switching costs, information asymmetry, or anticipated sanction. Conversely, possession of resources or formal authority does not establish realized power over a specified target unless a mechanism links those resources to the affected position's possibilities. Measurement should therefore preserve the carrier, mechanism, target, alternatives, and horizon.

Definition 22.845 (Power measurement profile). *A power measurement profile records the focal carrier or configuration, affected position, power-relevant asymmetry, conditioning mechanism, observable manifestations, feasible alternatives, dependence structure, resistance or contestability, temporal horizon, persistence, latent and exercised components where distinguishable, and competing explanations for the observed outcome.*

Potential indicators include concentration, switching costs, veto rights, agenda-setting control, access to scarce infrastructure, control of standards, information asymmetry, dependency duration, conversion privileges, or observed responsiveness of one position to another. Their interpretation remains mechanism-specific. Market share can indicate one resource asymmetry while providing weak evidence of institutional or epistemic power in a particular case. A network-centrality measure can identify structural position without by itself showing that the position conditions another actor's alternatives.

Proposition 22.846 (Power-score nonuniversality). *A scalar power score has defensible GRE meaning only within a specified domain in which its components have a justified relation to the relevant power mechanism and comparison task; it should not be interpreted as a universal measure of total power across heterogeneous mechanisms.*

Power measurement should also treat non-use carefully. Absence of overt intervention can indicate lack of power, successful deterrence, institutionalized compliance, mutually accepted coordination, or simply no occasion for exercise. Distinguishing these interpretations generally requires process evidence and counterfactual information about available alternatives rather than a frequency count of visible interventions.

22.22.8 Justice Indicators

Justice indicators occupy a different epistemic position because they combine empirical representation with normative interpretation. Section 22.12 therefore separated the justice-research profile from the normative-premise register. The measurement problem is to preserve that separation when institutions demand dashboards, thresholds, rankings, targets, or composite indices.

An indicator can measure income distribution, effective access, exposure to harm, participation, waiting time, conversion loss, intergenerational burden, option preservation, transfer incidence, or another justice-relevant manifestation. Whether a given distribution is unjust does not follow from the measurement alone. The judgment depends on a principle concerning equality, sufficiency, priority, desert, need, rights, historical responsibility, reciprocity, procedural standing, capability,

or another normative basis. Different principles can also select different affected positions and comparison units.

Definition 22.847 (Justice-indicator specification). *A justice-indicator specification records the empirical construct, affected positions, indicator and data source, distribution or threshold being represented, temporal horizon, relevant historical conditions, normative premise or premises, aggregation or priority rule, uncertainty, omitted justice-relevant dimensions, and the scope within which the indicator is intended to inform rather than determine judgment.*

This specification protects against two common collapses. The first is empirical reduction: a multidimensional justice question becomes whatever the available dataset happens to measure. The second is normative concealment: a weighting or threshold rule is presented as a technical property of the index even though it embodies a substantive judgment.

Proposition 22.848 (Indicator–judgment separation). *A justice indicator can support a normative judgment only through an explicit bridge connecting the measured manifestation to affected positions and stated normative premises; numerical precision in the indicator does not remove the need to justify that bridge.*

Justice dashboards can still be useful. They can make disparities visible, identify thresholds, trace institutional change, and support accountability. Stronger designs preserve component measures, show sensitivity to weights and boundaries, disclose missing populations, and allow disagreement about the normative interpretation. Where relevant values are incommensurable, the dashboard can retain parallel indicators rather than forcing a synthetic rank.

22.22.9 Measurement-Induced Distortion

Measurement can change the field it measures. Once an indicator becomes tied to funding, ranking, eligibility, compliance, performance review, professional status, or public legitimacy, participants can redirect attention and resources toward the measured dimension. This response is not necessarily manipulation. It can be a rational adaptation to institutional incentives. Yet the resulting improvement in the indicator can diverge from improvement in the underlying construct.

Distortion can arise through strategic gaming, classification changes, threshold optimization, documentation effort, selective participation, data suppression, substitution away from unmeasured activities, or the abandonment of difficult cases. It can also arise more quietly through attention. What is measured receives organizational visibility; what is not measured can become harder to defend in budgeting and governance. Measurement burden itself can redistribute time and capacity, especially toward positions already responsible for care, maintenance, compliance, or documentation.

Definition 22.849 (Measurement-induced distortion profile). *A measurement-induced distortion profile records the target construct, indicator or classification, institutional use of the measure, actors exposed to that use, behavioral and organizational response channels, changes in reporting or classification, shifts in resource allocation and attention, burden of measurement, effects on unmeasured dimensions, distribution of gains and losses, and evidence concerning divergence between indicator performance and the underlying research object.*

The profile also captures classification effects. A threshold can create new strategic categories; a ranking can reorganize competition; an eligibility rule can encourage actors to alter observable characteristics; a performance metric can change which tasks are undertaken. In these cases, the measure becomes part of the causal configuration. A later researcher who treats it as a passive record can misidentify the direction of influence.

Measurement distortion can propagate through the GRE architecture. A distorted value measure can alter conversion decisions. A narrow generativity indicator can incentivize visible outputs at the expense of maintenance. A power metric can privilege forms of power that are easiest to observe. A justice dashboard can improve recorded parity while leaving relational or historical injustice unchanged. The research programme therefore requires monitoring not only whether an indicator predicts or correlates with a target, but also what happens when the indicator acquires institutional consequence.

Proposition 22.850 (Measurement reflexivity condition). *When a measure materially affects incentives, classification, attention, allocation, participation, or governance in the field being studied, the resulting feedback should be represented as part of the causal and historical research object rather than treated solely as measurement error.*

A robust measurement programme consequently needs versioning and withdrawal conditions. Indicators should be revised when their construct meaning drifts, when strategic response dominates the intended signal, when excluded populations become material, when a comparison ceases to preserve meaning, or when measurement burden materially changes the field. In some cases the appropriate response is better measurement. In others it is multiple indicators, less frequent measurement, qualitative supplementation, separation of learning metrics from accountability metrics, or deliberate refusal to quantify a construct beyond the available warrant.

Definition 22.851 (Measurement revision register). *A measurement revision register preserves successive versions of a measure together with their construct definitions, data-generating processes, coding and aggregation rules, known distortions, validation evidence, institutional uses, reasons for revision, and implications for comparability with earlier results.*

Taken together, the nine problems make measurement a constitutive part of GRE research design. Relational structure, generative capacity, heterogeneous value, conversion, option space, history, power, and justice can each be measured, but none is guaranteed to survive measurement unchanged. The research task is therefore to construct measures whose provenance, losses, scope, and reflexive effects remain visible enough for later researchers to reinterpret or reject the claims built from them.

Proposition 22.852 (Measurement answerability). *A GRE measurement architecture remains answerable when its constructs, manifestations, transformation rules, comparison assumptions, residual omissions, uncertainty, and reflexive effects are sufficiently explicit that later evidence can support recalibration, disaggregation, reinterpretation, or abandonment without reconstructing the original measurement logic from inference alone.*

This condition prepares the next stage of the research programme. Once measurement claims are explicit and revisable, GRE can state more clearly what would count as counterevidence to its empirical, mechanistic, historical, and formal claims. The next section therefore turns from measurement adequacy to falsification and counterevidence.

22.23 Falsification and Counterevidence

The role of this section is to specify how claims within the GRE research programme can lose support. Earlier chapters treated failure, negative results, and revision as general features of research praxis, while Sections 22.1–22.22 converted GRE concepts into explicit research programmes, designs, measurements, and comparison procedures. The present objective is narrower: to identify what kinds of evidence count against different GRE claims, how adverse results should be diagnosed when auxiliary assumptions and measurement relations are involved, when a failure should remain local, and when accumulated counterevidence should trigger revision of a wider framework commitment.

The section proceeds through disconfirming cases, failed predictions, failed mechanisms, alternative explanations, domain failure, historical counterexamples, formal counterexamples, and revision triggers. The method is claim-indexed. GRE includes universal-looking propositions, probabilistic tendencies, mechanism claims, historical reconstructions, domain translations, formal representations, normative evaluations, and open hypotheses. These do not share one identical falsification rule. A valid counterexample can defeat a universal proposition under its stated assumptions, whereas a probabilistic claim can remain viable after some contrary cases while becoming less well supported. A historical reconstruction can be weakened by contradictory provenance or chronology, while a normative judgment requires criticism of its premises or their application rather than an empirical observation alone. The programme therefore needs a common architecture for counterevidence without pretending that every claim is falsified in the same way.

Definition 22.853 (GRE counterevidence dossier). A *GRE counterevidence dossier* records the target claim and version, claim status and intended scope, stated assumptions and boundary conditions, observable or reconstructible implications, evidential or formal procedure used to evaluate the claim, relevant auxiliary assumptions, measurement and classification relations, adverse result, rival interpretations of that result, effect on the claim's support, unresolved diagnostic uncertainty, and possible revision targets.

The dossier prevents adverse evidence from being treated either as automatically decisive or as indefinitely absorbable. A contrary observation matters only through a defensible bridge to the claim under examination. At the same time, the presence of auxiliaries cannot become a standing permission to protect a preferred claim from every difficult result. The purpose of recording the surrounding configuration is to improve diagnosis and later discrimination.

Proposition 22.854 (Claim-indexed vulnerability). A *GRE claim remains empirically or analytically answerable only when the programme can state, at a level appropriate to the claim type, which observations, reconstructions, comparisons, formal results, or rival explanations would materially reduce support for its current formulation.*

Table 22.23 summarizes the principal counterevidence forms developed below.

22.23.1 Disconfirming Cases

A disconfirming case is stronger than an unusual observation. The case must fall within the declared scope of the claim, be described using evidence adequate to the comparison, and exhibit a result materially inconsistent with the implication being

Table 22.23: Principal forms of counterevidence in the GRE research programme

Counterevidence form	Primary object under pressure	Diagnostic burden	Possible programme response
Disconfirming case	Scope-bounded empirical or interpretive claim	Establish case admissibility, evidential adequacy, and relevance to the claim	Retest, narrow scope, differentiate the claim, or withdraw a universal formulation
Failed prediction	Ex ante directional, quantitative, temporal, or configurational expectation	Preserve the prior prediction, tolerance, horizon, and auxiliary assumptions	Recalibrate, revise mechanism, contract scope, or reduce predictive status
Failed mechanism	Claimed generative or causal process	Distinguish outcome occurrence from evidence that the proposed process produced it	Replace, decompose, supplement, or suspend the mechanism claim
Alternative explanation	Explanatory superiority or necessity claim	Compare rivals on shared evidence, assumptions, residuals, and discriminating observations	Defer to the rival, combine mechanisms, narrow explanatory scope, or redesign the test
Domain failure	Cross-domain portability of a construct, mechanism, or formalism	Verify translation adequacy before attributing failure to the source concept	Contract the domain, build an interface, revise the concept, or record non-transferability
Historical counterexample	Historical generalization, trajectory claim, or category projection	Reconstruct period-specific categories, chronology, provenance, and observability	Periodize, revise the historical mechanism, narrow the claim, or reject presentist transfer
Formal counterexample	Formal proposition, representation, or mapping	Check assumptions, derivation, target correspondence, and boundary cases	Correct mathematics, weaken the theorem, retreat formally, or change representation
Revision trigger	Current framework formulation and dependent research streams	Assess severity, recurrence, independence, propagation, and unresolved alternatives	Clarify, differentiate, contract, replace, suspend, or withdraw the affected claim

tested. These requirements matter because relational and historical research can otherwise become too elastic. An apparently adverse case can always be redescribed as exceptional, context-specific, insufficiently relational, or historically incomparable after the fact. Such responses can sometimes be correct, but they require independent justification if the framework is to remain answerable.

Definition 22.855 (Disconfirming-case profile). A *disconfirming-case profile* records the target claim, declared scope, case-selection rationale, evidence establishing that the case falls within that scope, expected implication, observed configuration or outcome, measurement and classification adequacy, relevant contextual differences, alternative explanations, and the proposed consequence for the claim.

The first diagnostic question is therefore case admissibility. Suppose a claim states that a specified form of relational allocation tends to preserve effective options under a stated set of institutional conditions. A case in which those conditions are absent does not directly disconfirm that formulation. By contrast, a well-documented case satisfying the stated conditions in which effective options predictably contract can place the claim under material pressure. The same logic applies to claims concerning generative return, power, exploitation, knowledge capacity, or institutional regeneration.

The evidential consequence depends partly on claim form. A genuinely universal proposition can be defeated by one admissible counterexample if the proposition and the case are both sufficiently well specified. A probabilistic or tendency claim usually requires a different evaluation. One contrary case can identify a boundary or omitted mechanism without eliminating the tendency, whereas a systematic pattern of contrary cases can materially reduce support for the proposed relation. A typological claim can fail because a supposedly exhaustive category set omits a recurring configuration. An interpretive claim can fail because the proposed meaning is inconsistent with stronger contemporaneous evidence or with the position-specific interpretation being attributed.

Proposition 22.856 (Case-admissibility condition). *A case should count materially against a GRE claim when the case satisfies the claim's independently stated inclusion conditions, the relevant evidence is adequate to the comparison, and the observed configuration conflicts with an implication whose failure was not introduced only after the result became known.*

This condition allows scope revision while making the revision visible. If a disconfirming case reveals that the original claim omitted a material boundary condition, narrowing the scope can be justified. The revised scope should then be versioned and exposed to new cases. Repeated contraction after each adverse observation without independent theoretical or evidential support indicates that the original generality was overstated.

Disconfirming cases are especially valuable when selected from positions where a GRE concept should plausibly perform well. If a proposed generativity concept fails only in a domain with weak data access and poorly defined temporal boundaries, diagnosis can remain ambiguous. If it fails in a well-observed domain whose conditions closely match the original formulation, the evidential pressure is stronger. Critical cases, deviant cases, and boundary cases therefore become part of falsification design rather than merely case-selection variety.

Definition 22.857 (Adverse-case ledger). *An adverse-case ledger preserves admissible disconfirming, boundary, deviant, and unresolved cases together with their evidential quality, diagnosis, effect on claim support, and later reinterpretation so that the programme does not retain only cases in which its preferred vocabulary succeeds.*

22.23.2 Failed Predictions

Prediction provides one of the clearest opportunities for a framework to encounter adverse evidence because the expected result can be recorded before observation. GRE does not require every inquiry to be predictive. Historical reconstruction, interpretive work, conceptual clarification, and some exploratory research have different epistemic purposes. Where a claim is presented predictively, however, the research programme should preserve the expectation with enough specificity to distinguish a genuine miss from later reinterpretation.

A prediction can fail in several ways. The direction can be wrong. The magnitude can fall outside the stated tolerance. The timing can be wrong even if the eventual direction is correct. The distribution across positions can differ from expectation. A predicted relational pattern can fail to emerge. A model can correctly predict an aggregate outcome while failing at the scale or subgroup central to the claim. These failures have different implications for mechanism and scope.

Definition 22.858 (Predictive commitment record). A *predictive commitment record* preserves the target quantity or configuration, predicted direction or range, temporal horizon, population or domain, tolerance or decision rule, uncertainty, relevant auxiliary assumptions, measurement specification, and date or research state at which the prediction was fixed before evaluation.

The record does not require rigid preregistration in every study. Its function is historical traceability. A forecast written in a dated project log, a model version with a fixed output rule, or a prospectively specified hypothesis can all serve when they preserve the pre-result commitment. What should be avoided is reconstructing the prediction from the observed outcome and then presenting the resulting fit as prior success.

Definition 22.859 (Prediction-failure record). A *prediction-failure record* links a predictive commitment to the realized evidence and identifies whether the miss concerns direction, magnitude, timing, distribution, scale, relational configuration, uncertainty calibration, or another prespecified dimension.

Auxiliary assumptions complicate interpretation. A prediction about value conversion can fail because the hypothesized conversion mechanism is wrong, because the interface changed, because a measurement rule no longer tracks the intended value form, or because an unmodeled institutional intervention altered the pathway. The appropriate response is not to declare either the whole framework falsified or the central hypothesis untouched. The programme should diagnose which components were independently supported and which remain candidates for revision.

Proposition 22.860 (Predictive-commitment condition). *The evidential force of a failed GRE prediction increases when the prediction, tolerance, horizon, target population or configuration, and principal auxiliary assumptions were specified before the relevant result and when the observed miss remains robust to reasonable measurement and model alternatives.*

A recurring predictive miss has programme-level importance even when no single failure is decisive. If a model repeatedly requires post-result changes to timing, boundaries, parameters, or auxiliary assumptions, its nominal predictive success can exceed its genuine prospective performance. Versioned prediction records allow the programme to measure improvement rather than replacing earlier expectations silently.

22.23.3 Failed Mechanisms

An outcome can occur while the proposed mechanism fails. This distinction is central to GRE because many of its claims concern generative pathways, conversion interfaces, power mechanisms, circulation structures, return relations, and historical processes rather than simple covariation. An intervention may increase an outcome through a different pathway from the one proposed. Two variables may move together because both respond to a third configuration. A relational pattern can reproduce while the hypothesized feedback loop is absent. Outcome correspondence therefore does not validate a mechanism by itself.

Definition 22.861 (Mechanism-evidence profile). A *mechanism-evidence profile* records the proposed mechanism, initiating conditions, intermediate states or relations, temporal ordering, expected process signatures, alternative pathways capable of producing the observed result, evidence for each intermediate link, intervention

or comparison opportunities, and the residual part of the outcome left unexplained.

Mechanism failure can appear through missing intermediates, incorrect ordering, absent dependence on the supposed carrier, failure under intervention, or the presence of the outcome when the mechanism's necessary conditions are absent. A proposed power mechanism can fail when the focal actor possesses resources but does not condition the target's alternatives. A generative-return mechanism can fail when resources return nominally while no change in later source-side capacity follows. A knowledge-capital mechanism can fail when accumulated artifacts increase but later mobilization depends on an unmodeled institutional relation.

Proposition 22.862 (Outcome–mechanism separation). *Observed occurrence of an outcome predicted by a GRE mechanism increases support for that mechanism only to the extent that evidence discriminates the proposed pathway from alternative pathways capable of producing the same outcome.*

This proposition guards against equifinality. A single economic configuration can be produced by several histories, and several mechanisms can generate similar aggregate manifestations. GRE's relational vocabulary can make this problem more visible because the same outcome may emerge from different configurations of dependence, coordination, coercion, learning, or institutional adaptation. Mechanism research therefore benefits from variation that separates pathways rather than only reproducing outcomes.

Definition 22.863 (Mechanism-failure dossier). *A mechanism-failure dossier records the target mechanism, supported and unsupported links, observed process deviations, alternative mechanisms, tests that discriminate among them, and whether the appropriate response is parameter revision, mechanism decomposition, mechanism replacement, scope contraction, or suspension of the mechanism claim.*

Repeated mechanism failure can matter even when prediction remains adequate. A model that predicts outcomes through a substantively incorrect process may still be useful for limited forecasting while becoming unsuitable for intervention, justice analysis, or institutional design. Claim status should therefore be updated at the level at which failure occurs.

22.23.4 Alternative Explanations

Counterevidence can take the form of a superior rival explanation rather than a direct contradiction. This possibility is particularly important for an integrative framework. A GRE analysis can describe a configuration accurately while adding little explanatory leverage beyond an established economic theory, a domain-specific mechanism, or a simpler historical account. In such cases, the burden is not only to show that GRE can redescribe the evidence. The programme should ask whether the relational-generative formulation explains, discriminates, predicts, reconstructs, or integrates something material that the rival does not.

Definition 22.864 (Rival-explanation dossier). *A rival-explanation dossier records a shared empirical or historical target, the principal explanatory claims of each account, their assumptions, mechanism commitments, evidential fit, residuals, complexity, domain boundaries, discriminating observations, and aspects of the case that remain untranslated or unexplained by each account.*

A rival can outperform a GRE account in different senses. It can explain the same

evidence with fewer unsupported assumptions. It can make a more precise successful prediction. It can identify a mechanism that GRE leaves generic. It can use a domain concept with greater empirical correspondence. It can better reconstruct historical sequence. It can expose a normative distinction that a broad relational vocabulary obscures. These forms of superiority should remain differentiated because they imply different responses.

Proposition 22.865 (Comparative-defeater condition). *When a rival explanation accounts for the relevant evidence more precisely or parsimoniously within the research task, survives available discriminating tests, and leaves no material GRE-specific explanatory remainder, the GRE claim should lose explanatory priority for that task even if the same case can still be expressed in GRE vocabulary.*

Losing explanatory priority need not require abandoning the wider framework. The result can indicate theoretical deference, domain specialization, or a narrower role for GRE as an interface language. In other cases, the rival and GRE accounts may explain different levels of the same configuration. A conventional price mechanism can explain a short-run allocation pattern while a relational account explains how the institutional conditions of that market were generated. Combination is justified only when the levels and interfaces are explicit rather than when additional mechanisms are added merely to preserve the preferred theory.

Definition 22.866 (Discriminating-evidence plan). *A discriminating-evidence plan specifies observations, interventions, historical traces, formal implications, or cross-domain comparisons expected to differ across rival explanations and records how each possible result would alter their relative support.*

The plan converts theoretical plurality into research design. Where no feasible observation discriminates the rivals, the appropriate status can remain unresolved rather than one theory being selected by rhetorical breadth.

22.23.5 Domain Failure

Domain failure occurs when a GRE construct, mechanism, measurement architecture, or formal representation does not retain adequate meaning or performance in a domain to which it has been extended. Section 22.16 treated domain studies as tests of GRE as well as applications of it. The present subsection specifies how a failed transfer should count against the attempted generalization.

The first burden is translation adequacy. A concept can appear to fail because it was transported using the wrong unit, timescale, normative standpoint, or institutional analogue. For example, a notion of return developed in a research institution may not map directly onto ecological regeneration, and a notion of exit developed in a platform market may misrepresent care relations. Before calling the source concept defective, researchers should establish that the target-domain translation preserves the relation relevant to the claim.

Definition 22.867 (Domain-failure profile). *A domain-failure profile records the source concept or mechanism, target domain, translation rule, expected preserved structure, domain-specific conditions, evidence of mismatch or failure, competing diagnoses, and whether the failure concerns translation, implementation, measurement, mechanism, or the attempted cross-domain generalization itself.*

A genuine domain failure can support several responses. The source concept can

remain valid locally while its portability is withdrawn. A domain interface can be added where specialized concepts are needed. The concept can be differentiated into several variants. A mechanism can be narrowed to institutional conditions under which it is actually observed. A formal representation can be abandoned for that domain while retained elsewhere.

Proposition 22.868 (Domain-contraction condition). *When a GRE claim fails repeatedly in a target domain after adequate translation, measurement, and design have been established, the programme should contract or differentiate the claim's domain unless independent evidence supports a specific omitted condition that generates a new discriminating test.*

The final clause is important. Adding a boundary condition can be legitimate when the condition is independently motivated and empirically addressable. It becomes weak protection when every failure generates a new context qualifier that cannot itself be tested. Because GRE emphasizes relations, history, and context, it faces a particular risk of becoming compatible with almost any observed result through retrospective contextualization. Domain contraction is therefore a positive research outcome when it increases correspondence between claim scope and evidence.

Repeated failure across substantially different domains can escalate the diagnosis. A concept that fails in one specialized domain may require a local interface. A concept that fails across education, care, platforms, ecology, and public institutions for different reasons can indicate that the general construct is underspecified or too broad to support cumulative inquiry. A domain-test portfolio should therefore preserve both successes and failures.

22.23.6 Historical Counterexamples

Historical counterexamples place temporal generalizations, path claims, genealogies, and projected categories under pressure. They require special care because the evidential record is uneven and because a later analytical concept can be mistakenly projected into periods where its institutional meaning, boundaries, or manifestations differed. A valid historical counterexample therefore requires more than finding an earlier event that appears inconsistent with a present formulation.

Definition 22.869 (Historical-counterexample dossier). *A historical-counterexample dossier records the target historical claim, period and trajectory under study, contemporaneous categories and institutional conditions, source provenance and survival pattern, chronology, evidential gaps, the apparent counterexample, alternative period-specific interpretations, and the implication for the temporal scope or mechanism of the claim.*

Several forms are possible. A sequence can contradict a proposed temporal ordering. A supposedly necessary precursor can be absent. An institution can persist after the mechanism said to reproduce it disappears. A path-dependence claim can fail when substantial reversal occurs under conditions that the theory treats as strongly locking in. A conceptual history can fail when the relevant term or distinction appears earlier, later, or through a different genealogy than proposed. A historical generalization about relational transformation can fail when cases with similar initial configurations follow substantially different trajectories.

Historical absence requires caution. Missing archival evidence can mean absence of the phenomenon, loss of records, non-documentation, exclusion from official cate-

gories, or limited preservation. The relevant counterevidence can therefore concern the historical claim or the archive's representational structure. Section 22.18 developed provenance and survival profiles precisely because historical counterevidence depends on what could have been recorded and preserved.

Proposition 22.870 (Historical-counterexample condition). *A historical case counts strongly against a GRE historical generalization when the case can be reconstructed within contemporaneous categories and conditions, the relevant evidence has adequate provenance, and the contradiction persists after plausible differences in observability, periodization, and institutional meaning are addressed.*

Historical counterexamples can also produce periodization rather than rejection. A mechanism may hold after the emergence of a particular legal form, infrastructure, accounting regime, or technological capacity but not before. Converting an apparently timeless claim into a historically bounded one can improve the programme by identifying the conditions under which the relation becomes possible.

22.23.7 Formal Counterexamples

Formal counterexamples have a comparatively sharp role when a proposition is mathematical. A theorem-like claim stated over a defined domain is defeated if a valid counterexample satisfies its assumptions while violating its conclusion. Yet the GRE formal programme also includes representations and models whose adequacy depends on correspondence with economic objects. Formal evaluation must therefore distinguish mathematical counterexample, representational counterexample, and empirical failure of a formalized model.

Definition 22.871 (Formal-counterexample record). *A formal-counterexample record preserves the formal claim or representation, domain and assumptions, candidate counterexample, verification that the assumptions are satisfied, violated conclusion or preservation criterion, computational or derivational checks, substantive interpretation where relevant, and the revision required for the formal or representational claim.*

A mathematical counterexample can reveal that a proposition is false as stated. A representational counterexample can show that two substantively different economic configurations map to the same formal state even though the research question requires them to remain distinct. An empirical counterexample can show that a model-generated implication fails in the target system despite mathematical coherence. These failures should not be conflated. Correct mathematics does not establish representational adequacy, and empirical mismatch does not by itself show that the mathematical derivation is invalid.

Formal counterexamples are especially useful for testing broad claims about invariance, equivalence, convergence, stability, ordering, or composition. Edge cases and boundary configurations can reveal hidden assumptions. Computational search, sensitivity analysis, symbolic checking, and constructive examples can all support this work, provided the resulting counterexample is interpreted relative to the stated formal domain rather than merely found outside it.

Proposition 22.872 (Formal-assumption condition). *A candidate formal counterexample defeats a formal proposition only when it satisfies the proposition's stated assumptions; when the candidate instead exposes an assumption that is too restrictive or substantively inappropriate for the intended economic target, the failure concerns*

model scope or representation rather than the theorem's internal validity.

This distinction is central to the stronger formalisms considered in Section 22.17. A 2-complex, operator-algebraic, or amplitude-like representation can remain mathematically well formed while proving unnecessary, underidentified, or structurally misleading for a particular economic problem. Formal retreat is then a legitimate result. A simpler representation can be preferable if it preserves the distinctions required by the research question with fewer assumptions.

Definition 22.873 (Formal-retreat criterion). *A formal-retreat criterion identifies conditions under which a GRE formalization should be replaced by a weaker or simpler representation because the stronger formal structure adds unsupported assumptions, produces non-identifiability, erases material distinctions, or fails to improve empirical or analytical discrimination.*

22.23.8 Revision Triggers

Counterevidence becomes cumulatively useful when it can trigger proportionate revision. Chapter 21 defined the GRE revision cycle and several revision classes. The present task is to operationalize the transition from an adverse result to that cycle. Not every anomaly warrants immediate change, while repeated or high-quality counterevidence should not be allowed to accumulate indefinitely without altering claim status.

Definition 22.874 (Counterevidence-to-revision record). *A counterevidence-to-revision record links an adverse result or set of results to the affected claim, evidential quality, recurrence, independence across methods or domains, implicated auxiliary assumptions, dependent claims, unresolved alternative diagnoses, current claim status, and the threshold or rationale for entering a revision cycle.*

Several features increase the importance of a revision trigger. The adverse result can be replicated or reconstructed independently. It can arise across methods whose main failure modes differ. It can occur in a critical domain close to the claim's intended center rather than only at a boundary. It can target a mechanism on which several later claims depend. A formal contradiction can invalidate multiple downstream derivations. A superior rival explanation can repeatedly outperform the GRE account. A measurement problem can undermine an entire empirical literature built on the same indicator. These forms of dependency mean that revision priority should consider propagation as well as local severity.

Auxiliary revision requires its own discipline. Changing a measurement, parameter, scope condition, or background assumption after counterevidence can be justified when the change has independent support and creates new discriminating expectations. It is weaker when the change only restores compatibility with the adverse result while reducing the claim's exposure to future tests.

Proposition 22.875 (Auxiliary-revision discipline). *An auxiliary revision made in response to counterevidence strengthens the research programme when it has independent justification, identifies a specific locus of failure, and creates additional observable, historical, or formal consequences through which the revised claim can be evaluated.*

This proposition protects against framework immunization. Relational and historical explanations are often capable of accommodating complexity because they admit context, path dependence, multiple scales, and interaction. These are substantive ad-

vantages only when the additional structure remains specified enough to constrain explanation. If every adverse result can be attributed after the fact to unspecified relations, hidden history, unobserved context, or a new scale, the framework becomes less rather than more informative.

Definition 22.876 (Framework-immunization signal). *A framework-immunization signal is a recurrent pattern in which adverse evidence is absorbed through newly introduced but weakly constrained auxiliaries, shifting scopes, or retrospective reinterpretations without corresponding increases in independent warrant or future discriminability.*

The presence of such a signal does not by itself determine which claim should be abandoned. It identifies a programme-level methodological problem requiring review. Possible responses include clarifying the claim, fixing its scope prospectively, separating several mechanisms, reducing formal or conceptual ambition, suspending the claim pending better evidence, or withdrawing it.

Proposition 22.877 (Proportionate revision trigger). *A GRE claim should enter formal revision when the accumulated counterevidence materially reduces support for its current formulation and when preserving the claim unchanged would require ignoring stronger evidence, repeated domain failure, formal inconsistency, superior rival explanation, or auxiliary adjustments whose independent warrant remains insufficient.*

Revision can contract scope, remove a mechanism, retreat to a weaker formalism, defer to a domain-specific concept, or mark a question unresolved. Such contraction is programme progress when it improves correspondence between claim strength and warrant.

Definition 22.878 (Counterevidence propagation map). *A counterevidence propagation map records which later concepts, models, empirical studies, normative analyses, domain translations, or interventions depend materially on a claim placed under revision so that the consequences of changing that claim can be inspected across the research programme.*

Taken together, the eight forms make openness operational. GRE becomes answerable when researchers can preserve admissible adverse cases and failed predictions, distinguish outcome from mechanism failure, compare rivals, record non-transferability, reconstruct historical and formal counterexamples, and propagate warranted revision through dependent claims.

Proposition 22.879 (Counterevidence answerability). *The GRE research programme remains answerable when materially adverse evidence can be preserved, attributed to a specified claim and research configuration, compared with plausible alternative diagnoses, and translated into proportionate changes of status, scope, mechanism, formalization, or framework without requiring the evidence to disappear from the programme's historical record.*

Counterevidence and negative results overlap without being identical. Counterevidence reduces support for a claim; negative results also include informative absences and failures that decisively disconfirm no well-formed claim. The next section therefore turns to their systematic preservation and analysis.

22.24 Negative Results

The role of this section is to specify how the GRE research programme should interpret and preserve informative failures that do not necessarily constitute direct falsification. Section 22.23 addressed counterevidence against claims whose scope, expected implication, mechanism, or formal structure is sufficiently specified for adverse evidence to reduce their support. Negative results form a wider class. A relation can fail to stabilize, an intervention can produce no detectable change, a value conversion can remain unrealized, a return flow can fail to regenerate source-side capacity, a formalization can prove unidentifiable, or a concept can resist transfer across domains without any one of these outcomes by itself refuting a well-formed proposition. The objective here is to make such results cumulative rather than allowing them to disappear as unsuccessful cases, unpublished analyses, abandoned models, or undocumented project detours.

The section proceeds through failed relations, failed generativity, failed value conversion, failed recirculation, failed intervention, failed formalization, non-transferable concepts, and preservation of negative evidence. The analytical method is diagnostic rather than merely classificatory. Each negative result is reconstructed as a path with attempted conditions, observed failure locus, uncertainty, plausible alternatives, and consequences for later research. This makes failure informative at the level of mechanisms, enabling conditions, measurement, design, scope, and resource allocation even when claim-level falsification is not warranted.

Definition 22.880 (GRE negative-result dossier). A *GRE negative-result dossier* records the attempted relation, process, intervention, conversion, formal representation, or conceptual translation; the conditions under which it was expected to become observable or workable; the relevant temporal and spatial boundaries; the evidence of non-occurrence, breakdown, instability, or non-transferability; implementation and measurement quality; competing diagnoses; unresolved uncertainty; and the consequences of the result for subsequent claims, designs, models, and research priorities.

Definition 22.880 distinguishes a negative result from a blank observation. Absence becomes informative only relative to a research architecture that specifies what was attempted, what opportunities for manifestation existed, how observation was conducted, and what alternative reasons could explain the result. A missing relation in inaccessible data, for example, carries a different evidential status from a repeatedly observed failure of relation formation in a well-instrumented field.

Proposition 22.881 (Negative-result informativeness condition). A *negative result contributes cumulatively to the GRE research programme when the attempted object and conditions are sufficiently specified, the opportunity for observation is credible, plausible implementation or measurement failures are differentiated from substantive failure, and the result changes at least one later research expectation, boundary, mechanism hypothesis, design choice, or allocation of investigative effort.*

Table 22.24 summarizes the principal negative-result domains developed below.

22.24.1 Failed Relations

Relational analysis can be biased toward relations that already exist because stabilized ties leave records, institutional forms, repeated transactions, recognizable roles,

Table 22.24: Principal negative-result domains in the GRE research programme

Negative-result domain	Characteristic failure	Principal research question
Failed relations	Expected relation does not form, stabilize, deepen, or remain mutually recognizable	Which enabling conditions, histories, asymmetries, interfaces, or coordination processes were absent or obstructive?
Failed generativity	Activity or resource flow occurs without producing the expected later capacity, relation, value, or option	Where did the proposed generative chain terminate, dissipate, or become dependent on an omitted condition?
Failed value conversion	A source value does not become an expected target value, or conversion is partial, lossy, delayed, or rejected	Was the failure caused by interface conditions, recognition regimes, incompatibility, power, measurement, or an invalid conversion assumption?
Failed recirculation	Resources or value fail to return, remain captured, dissipate, or return without regeneration	Which pathway, institutional interface, timing condition, or source-side capacity prevented effective recirculation?
Failed intervention	Intervention is not implemented, has no detectable effect, produces reversal, or generates unintended deterioration	Does the result concern design, implementation, mechanism, context, timescale, adaptation, ethics, or the intervention claim itself?
Failed formalization	Formal representation is ill-posed, unidentifiable, unstable, empirically ungrounded, or analytically unhelpful	Which assumptions or representational commitments created the failure, and should the model be simplified, reformulated, or abandoned?
Non-transferable concepts	A concept loses material meaning or correspondence when moved across domains or histories	Is the result a boundary of the source concept, a translation failure, or evidence for a domain-specific concept?
Preservation of negative evidence	Informative failures are selectively lost, compressed, or unpublished	How can provenance, failed paths, null findings, abandoned models, and later reinterpretations remain available to cumulative inquiry?

and observable interaction. Failed relation formation is often less visible. An attempted collaboration can dissolve before formalization, a trust relation can fail to emerge, a cooperative institution can remain nominal, a market interface can fail to connect positions, or repeated contact can occur without producing the relation expected by the research design. These outcomes are analytically important because GRE assigns a substantial role to relation formation, stabilization, and transformation.

A failed relation should be distinguished from absence of contact. Relation formation can require encounter, mutual recognition, compatible expectations, coordination resources, acceptable risk, temporal continuity, enforceable commitments, mediation, and sufficiently open future options. Different relation types require different subsets of these conditions. A negative result can therefore reveal a missing interface rather than a universal inability of two positions to relate.

Definition 22.882 (Failed-relation profile). A *failed-relation profile* records the focal positions, intended or expected relation type, opportunity for encounter, initiating events, required enabling conditions, pre-existing asymmetries and histories, attempted mediation or coordination, observed partial relations, breakdown point, persistence horizon, and evidence bearing on why the relation did not stabilize.

This profile prevents a common inferential shortcut. If a relation does not form, the result does not immediately establish that cooperation, trust, exchange, or coordination is impossible. The failure can be local to timing, sequencing, institutional design, recognition, or pre-existing power. It can also reveal that the proposed relation type was analytically misclassified. What was treated as a possible reciprocal collaboration can in practice require authority, brokerage, or asymmetric dependence.

Failed relations are especially informative for initial-condition research. A weak initial tie can sometimes generate repeated interaction and self-reinforcement,

whereas a slight difference in entry conditions can produce durable non-formation. Comparative study of near-matched successful and failed starts can therefore illuminate thresholds, mediation requirements, and historical lock-in more effectively than studying mature relations alone.

Proposition 22.883 (Relation-failure localization condition). *A failed relation should alter a general relational claim only after research distinguishes failure of opportunity, initiation, recognition, coordination, stabilization, and persistence from failure of the proposed relation type itself.*

The negative result can nevertheless be theoretically productive even before that distinction is fully resolved. Repeated failure at the same interface can identify an omitted mechanism. Repeated failure only under strong pre-existing asymmetry can connect relation formation to the power programme. Failure that disappears after mediation can identify mediation capacity as an enabling condition. The relevant output is therefore a localized account of where relation formation ceased to be generative, not merely a binary record that the relation was absent.

22.24.2 Failed Generativity

Generativity claims are vulnerable to a distinctive class of negative results because visible activity can occur without producing the later capacities or options that justify calling the activity generative. Funding can be spent, training can be delivered, knowledge can be produced, participation can increase, or institutional routines can be expanded while later capability, relational capacity, regeneration, or option-space remains unchanged. Such cases should not be dismissed as implementation noise simply because the proximal activity occurred as planned.

Section 22.8 distinguished return from generative return, while Sections 22.9 and 22.10 emphasized temporal depth and fast-slow dynamics. Negative-result analysis therefore requires a generative chain with enough temporal structure to identify where expected downstream change failed to emerge.

Definition 22.884 (Generative-chain failure record). *A generative-chain failure record specifies the initiating resource, relation, institution, or event; the expected intermediate changes; the later capability, relation, value, knowledge, or option that would evidence generativity; the observation horizon; enabling conditions; realized intermediate states; and the earliest stage at which the proposed chain ceases to receive evidential support.*

Several diagnoses are possible. The initial activity can be consumed rather than converted into durable capacity. A generated capability can remain unusable because complementary infrastructure is missing. A relation can form but fail to survive the relevant timescale. A proximal gain can be offset by a slower deterioration elsewhere. Benefits can accrue to positions other than those expected to regenerate the process. A useful capacity can emerge but remain invisible to the selected measure. These diagnoses imply different revisions.

Proposition 22.885 (Generativity non-occurrence condition). *A proximal success should count as a negative result for a generativity claim when the later change specified by that claim fails to become observable within an adequate horizon and when measurement, exposure, and complementary enabling conditions have been examined sufficiently to localize the missing generative link.*

This condition protects the concept of generativity from becoming synonymous with activity or benefit. It also guards against indefinite temporal deferral. A programme should not respond to every absent downstream effect by claiming that generativity may appear later. The intended horizon should be justified in advance where possible, and later extensions should be recorded as revisions.

Failed generativity can be one of the most useful negative results in GRE because it reveals where resources stop reproducing future possibility. Comparative portfolios can identify recurrent bottlenecks, including missing institutional memory, insufficient maintenance, lack of complementary capability, capture before return, dependency on a single intermediary, or option foreclosure after initial gain. These bottlenecks can then become direct objects of later research.

22.24.3 Failed Value Conversion

Value conversion research is especially susceptible to survivorship bias. Successful conversions leave visible outcomes: credentials become employment access, care becomes restored capability, knowledge becomes institutional practice, ecological stewardship becomes resilience, or symbolic recognition becomes resource access. Failed conversions can leave only the source-side effort, unrecognized value, or abandoned pathway. Their systematic preservation is therefore necessary for a theory that treats value as heterogeneous and conversion as conditional.

A conversion can fail because no interface exists, because the receiving institution does not recognize the source value, because conversion costs exceed accessible resources, because the source and target forms are not commensurable, because power controls the gate, because timing is wrong, or because the researcher's assumed conversion relation never existed. Partial conversion, delay, and irreversible loss should also be distinguished from complete failure.

Definition 22.886 (Value-conversion failure profile). *A value-conversion failure profile records the source value form, intended target value form, conversion interface, recognition rule, required complementary resources, relevant gatekeepers, temporal window, attempted conversion, realized partial outputs, losses, rejected or unrecognized residues, and evidence bearing on whether the assumed conversion pathway was technically, institutionally, normatively, or conceptually available.*

Failed conversion can carry normative significance without automatically constituting injustice. A caregiver's experience may fail to convert into labor-market credentials because no recognition institution exists. Community knowledge may fail to convert into formal policy influence because participation rules are inaccessible. Research evidence may fail to convert into institutional learning because authority and incentives remain unchanged. Each case requires separate analysis of the conversion interface and any relevant justice or power claim.

Proposition 22.887 (Conversion-failure differentiation). *A failed value conversion should be analyzed separately as absence of an interface, inaccessible interface, rejected recognition, prohibitive conversion cost, incompatible value forms, temporal mismatch, or failure of the hypothesized conversion relation, because these diagnoses imply different consequences for theory and intervention.*

Negative conversion results also constrain comparative valuation. If repeated studies show that a value form cannot be converted without destroying the property that makes it valuable, attempts to represent that conversion with a stable rate should

lose standing. Non-conversion can therefore be evidence for a genuine boundary of commensurability rather than merely a technical inefficiency.

22.24.4 Failed Recirculation

GRE distinguishes circulation from return, and return from regeneration. Negative results occur at each stage. Value can fail to circulate beyond an initial node, circulate outward without returning, return nominally but too late to preserve the source, or return in a form that the source cannot use. A flow can also appear circular at the aggregate level while particular source relations lose capacity. Research on failed recirculation therefore requires pathway-specific and position-specific analysis.

Definition 22.888 (Recirculation failure trace). A *recirculation failure trace* records the originating position or relation, value or resource form, expected circulation path, intermediaries, conversion points, capture or dissipation sites, return path, delay, returned form, source-side absorptive capacity, and the point at which effective return or regeneration fails.

The trace supports several diagnoses. A pathway can terminate in capture. Value can dissipate through transaction, coordination, or maintenance costs. An intermediary can redirect the return. The returned resource can be formally equivalent yet functionally unusable. A delayed return can arrive after the source relation has dissolved. A source can lack capacity to absorb the returned resource because prior extraction degraded the very infrastructure required for regeneration.

Proposition 22.889 (Recirculation effectiveness condition). A *recorded return flow* should count as successful recirculation only when the returned value or resource reaches the relevant source-side configuration in a usable form and within a horizon in which it can participate in the regeneration or maintenance claimed by the research design.

This proposition makes negative recirculation results visible even when accounting identities balance. Money can return while trust, knowledge, ecological capacity, or institutional continuity does not. Conversely, a non-monetary return can regenerate a source even when nominal resource flow is small. Failed recirculation therefore offers a direct test of whether the selected representation preserves the value form and timescale relevant to the proposed generative loop.

Longitudinal portfolios of failed recirculation can also reveal cumulative fragility. A system can continue operating through reserves while repeated small failures erode maintenance capacity. Such cases connect negative-result research to fast-slow dynamics: short-run continuity can coexist with slow deterioration in the structures that make future circulation possible.

22.24.5 Failed Intervention

Section 22.21 treated intervention as a research object whose design, implementation, adaptation, monitoring, and ethical constraints remain traceable. Negative-result analysis adds a complementary question: what can be learned when an intervention does not work as expected? The category is broader than a null treatment effect. Implementation can fail, exposure can be weak, participants can adapt strategically, institutional authority can block the mechanism, effects can reverse after withdrawal,

benefits can appear in one position while losses occur elsewhere, or the intervention can be stopped for ethical reasons before efficacy is known.

Definition 22.890 (Failed-intervention classification). *A failed-intervention classification distinguishes design failure, implementation failure, exposure failure, mechanism failure, measurement failure, adaptation or displacement, temporal failure, transfer failure, ethical termination, and substantively null or adverse effect, while preserving evidence for more than one category when diagnoses remain unresolved.*

This classification matters because a failed intervention can contain usable knowledge without supporting the same inference across categories. Poor implementation does not establish that the mechanism is ineffective. A well-implemented intervention with a stable null result is more informative about the mechanism, provided the outcome and horizon are adequate. Ethical termination can reveal a constraint on feasible experimentation without revealing whether the intervention would have produced the intended outcome.

Proposition 22.891 (Intervention-failure learning condition). *A failed intervention becomes a cumulative research result when the programme preserves enough design and process evidence to distinguish what failed, identifies which claims remain unresolved, and changes the design, mechanism hypothesis, monitoring architecture, ethical boundary, or transfer scope of subsequent interventions.*

Negative intervention results should also include reversibility failures. A programme can restore the formal pre-intervention rule while leaving altered expectations, dependencies, investments, data exposure, institutional memory, or option-space. If rollback does not restore the relevant configuration, that difference is itself a negative result about the assumed reversibility of the intervention architecture.

Publication practice is important here. Organizations have incentives to foreground successful pilots and suppress null or adverse interventions. GRE research infrastructure should therefore preserve failed implementation histories and terminated experiments with enough contextual detail to avoid both repetition and overgeneralization. A failed intervention in one institutional configuration can be highly informative without becoming a universal prohibition against similar interventions elsewhere.

22.24.6 Failed Formalization

Formal research can fail before any proposition is formally false. A model can be mathematically coherent yet impossible to identify from available evidence, too sensitive to unobservable assumptions, incapable of preserving a material relational distinction, or so expressive that it ceases to discriminate among relevant explanations. A proposed category-theoretic, operator-algebraic, field, geometric, network, or 2-complex representation can also prove unnecessary for the research problem even when internally valid. These are negative results about formalization as a research strategy.

Definition 22.892 (Formalization failure profile). *A formalization failure profile records the target research object, intended analytical gain, formal objects and assumptions, required observables, identification or calibration requirements, computational demands, preserved and lost substantive distinctions, sensitivity to assumptions, comparison with simpler representations, and the point at which the formalization becomes invalid, ungrounded, unidentifiable, unstable, or non-*

informative for the research task.

Several failure modes should be kept separate. *Ill-posedness* occurs when the formal problem lacks a sufficiently defined solution or stable interpretation. *Non-identification* occurs when available observations cannot distinguish parameter values, mechanisms, or structures material to the claim. *Representational loss* occurs when mathematically convenient objects erase a distinction central to the substantive question. *Empirical detachment* occurs when the quantities required by the formalism have no credible observational bridge. *Complexity without leverage* occurs when a richer formalism adds assumptions or computational burden without generating a material new inference.

Proposition 22.893 (Formalization stopping condition). *A formal research path should be simplified, suspended, or abandoned when additional formal structure no longer yields a defensible gain in representation, discrimination, inference, or empirical correspondence relative to its added assumptions and evidential demands.*

A failed formalization should not be treated as wasted effort. It can reveal which distinctions resist quantification, which observables are missing, which assumptions are too strong, or which mathematical language is mismatched to the empirical object. Such results can guide a move from amplitude-like to stochastic representations, from field models to network models, from operator language to direct process tracing, or from formalization to historical interpretation. The result therefore belongs in the research record together with the reasons for retreat.

Formal negative results also protect ontological restraint. If a mathematically elegant representation repeatedly lacks empirical correspondence, GRE should not preserve it through ontological assertion. The model can remain a heuristic or exploratory analogy, but its epistemic status should be downgraded accordingly.

22.24.7 Non-Transferable Concepts

Chapter 21 and Sections 22.16 and 22.20 developed translation, domain testing, and comparative theory without requiring equivalence. Negative-result research extends that discipline by treating non-transferability as a substantive result. A concept can work within one economic domain, institutional history, or scale while losing analytical correspondence when transported elsewhere. The correct response can be to preserve the boundary rather than repeatedly stretching the concept until it becomes universally applicable.

Definition 22.894 (Non-transferability record). *A non-transferability record identifies the source concept, source domain and historical conditions, target domain, proposed translation rule, structure expected to be preserved, observed mismatch, unsuccessful translation variants, domain-specific remainder, and the consequence for the claimed portability or generality of the concept.*

Non-transferability can arise for different reasons. The units can differ. The relevant relation can be absent. A value distinction can be domain-specific. The timescale can be incompatible. Legal or institutional categories can have no functional analogue. A subject position can be constituted differently. Translation can also fail because moving the concept would erase a normative or historical distinction that the target domain requires.

Proposition 22.895 (Non-transferability preservation condition). *When repeated*

translation attempts fail to preserve a concept's material analytical structure without importing unsupported assumptions or erasing target-domain distinctions, the research programme should preserve non-transferability as a scoped result rather than treating universal extension as the default objective.

This result can improve rather than weaken GRE. A framework that records where its concepts stop working can coordinate differentiated domain theories more precisely. It can also reveal candidate higher-level structures that are genuinely more abstract than the failed source concept. Conversely, if a concept transfers only after becoming so general that it no longer constrains observation, the apparent success is analytically weak.

Negative translation results should therefore be searchable across the research programme. Patterns of non-transferability can identify clusters of domains that share some structures but not others, expose hidden assumptions in supposedly general vocabulary, and prevent later researchers from repeating unsuccessful equivalence projects without awareness of their predecessors' results.

22.24.8 Preserving Negative Evidence

Negative results become methodologically valuable only if they survive. Research systems often preserve successful models, significant effects, stabilized institutions, completed interventions, and publishable theories more effectively than null findings, abandoned formalisms, failed translations, unsuccessful pilots, and unresolved cases. This creates a selective research memory. GRE requires an infrastructure in which the absence of success does not imply the absence of a record.

Definition 22.896 (Negative-evidence preservation record). A *negative-evidence preservation record* stores the negative-result type, original research question, versioned claim or design, data and code provenance where applicable, temporal and domain boundaries, implementation quality, analytic decisions, observed failure or non-occurrence, uncertainty, competing interpretations, reasons for stopping, publication status, and links to later replication, reinterpretation, or revision.

Preservation should distinguish negative evidence from low-quality evidence. A null result produced by severe measurement failure should remain archived, but it should not receive the same standing as a high-powered, well-implemented null study. An abandoned model because of computational inconvenience differs from a model abandoned because its parameters are structurally unidentifiable. A failed translation rejected after one superficial attempt differs from repeated failure under several well-specified mappings. Metadata about evidential quality is therefore part of preservation.

A second requirement is retrieval. Negative evidence that exists only in private notebooks, inaccessible repositories, or unindexed appendices can have little cumulative effect. Research infrastructure should support search by concept, domain, mechanism, intervention type, formalism, failure locus, and reason for withdrawal. Version links should connect a negative result to the claim or model that existed when the failure occurred rather than only to its later repaired version.

Proposition 22.897 (Negative-evidence memory condition). A *cumulative GRE research programme should preserve negative results with enough provenance, quality metadata, and version linkage that later researchers can determine what was attempted, why it failed or remained inconclusive, and whether changed conditions*

justify renewed inquiry.

Preservation also supports re-epistemization. A result classified as failure at one time can acquire a different interpretation when new concepts, data, or methods become available. An apparently null relation can later be recognized as scale-dependent. A failed formalization can become tractable after new observables are collected. A non-transferable concept can acquire a valid interface after institutional change. The original record should remain available so that reinterpretation does not erase its historical epistemic status.

Definition 22.898 (Negative-result portfolio). A *negative-result portfolio* is a versioned collection of failed relations, generative chains, conversions, recirculation pathways, interventions, formalisms, and conceptual translations organized so that recurrent failure loci, domain boundaries, unresolved diagnoses, and later re-openings can be compared across projects.

Proposition 22.899 (Negative-result cumulation). *Negative results strengthen GRE as an open research programme when they constrain repetition, expose recurrent boundary conditions, redirect scarce research resources, preserve failed alternatives for later reinterpretation, and remain capable of changing the status or scope of claims without being forced into the stronger category of falsification.*

The resulting research memory changes the meaning of failure. A negative result is neither automatically a defect in the framework nor a disposable absence of success. Its contribution depends on how precisely the attempted process is reconstructed and whether the result remains available to alter later inquiry. The next stage of the programme can then ask whether results, including negative ones, survive empirical replication, model reproduction, conceptual reconstruction, and reinterpretation under changing historical categories.

22.25 Replication and Reinterpretation

The role of this section is to specify how the GRE research programme can revisit earlier findings without treating recurrence, reproduction, reinterpretation, and historical updating as a single operation. Sections 22.18 and 22.19 developed historical, interpretive, quantitative, and empirical research programmes; Sections 22.23 and 22.24 developed counterevidence and negative results. Replication and reinterpretation connect these programmes across time. Replication asks which parts of a claim, mechanism, model, or empirical pattern remain supportable when relevant observations or procedures are repeated under a specified relation to the original study. Reinterpretation asks how an existing evidential record should be understood when later concepts, categories, methods, historical knowledge, or institutional conditions change. The objective is to make both processes cumulative while preserving provenance and the difference between the epistemic situation of an earlier inquiry and that of a later one.

The section proceeds through empirical replication, historical reinterpretation, cross-cultural reinterpretation, model replication, conceptual replication, failed replication, reanalysis under new categories, and longitudinal re-epistemization. The method is versioned and relational. Each recurrence identifies what is intended to remain invariant, what is permitted to differ, and which contextual differences can change the meaning of an apparent replication. Each reinterpretation preserves

Table 22.25: Principal operations in GRE replication and reinterpretation

Operation	Primary object	Principal research question
Empirical replication	Claim, effect, mechanism, relation, or pattern examined with new observations	Which result survives under a specified recurrence of population, setting, measurement, exposure, and relational conditions?
Historical reinterpretation	Earlier event, institution, archive, or reconstruction revisited under later evidence or concepts	Which part of the earlier interpretation remains warranted, and which part changes when the historical evidential field changes?
Cross-cultural reinterpretation	Concept, relation, institution, or process examined across culturally and institutionally differentiated settings	What is genuinely comparable, what requires translation, and what remains locally irreducible?
Model replication	Formal or computational result reproduced from data, code, equations, parameters, or algorithms	Can the reported result be regenerated, and does regenerated output preserve the same substantive interpretation?
Conceptual replication	Conceptual distinction or mechanism reconstructed across cases, domains, or periods	Does the concept retain its constitutive structure without being reduced to a shared label?
Failed replication	Material divergence from an adequately specified recurrence	Does divergence concern implementation, measurement, context, time, stochastic variation, mechanism, or the original claim?
Reanalysis under new categories	Preserved evidence recoded or reinterpreted with a later category system	What becomes newly visible, and which comparisons with the original analysis remain legitimate?
Longitudinal re-epistemization	Versioned sequence of evidence, categories, methods, and interpretations through time	How does the warranted knowledge state evolve while earlier epistemic states remain reconstructable?

the earlier evidence, categories, and warranted conclusions before adding the later analytical frame. This architecture allows stability and revision to coexist without requiring either timeless reproducibility or unrestricted reinterpretive flexibility.

Definition 22.900 (GRE replication–reinterpretation dossier). A *GRE replication–reinterpretation dossier* records the original claim, reconstruction, concept, model, or intervention result; its version and evidential basis; the elements intended to remain invariant; the dimensions deliberately or unavoidably changed; the replication or reinterpretation protocol; source and new evidence; measurement and category correspondence; relational, institutional, cultural, and historical differences; observed convergence or divergence; competing explanations; and the consequences for the status, scope, or interpretation of the original result.

Definition 22.900 makes the object of recurrence explicit. Repeating a procedure in another year, population, jurisdiction, culture, platform, or institutional regime can reproduce the outward method while changing the relations that made the original result meaningful. Conversely, a later analysis can use different methods yet provide a strong test of the same mechanism or relational configuration. Replication quality therefore depends on preservation of the relevant analytical structure, not merely on surface procedural similarity.

Proposition 22.901 (Version-preserving recurrence condition). A *replication or reinterpretation contributes cumulatively when it preserves the provenance and epistemic status of the earlier result, specifies the structures expected to recur or remain interpretable, records material changes in conditions and categories, and permits the later result to revise the earlier claim without retrospectively rewriting what the earlier evidence supported.*

Table 22.25 summarizes the principal operations developed below.

22.25.1 Empirical Replication

Empirical replication examines whether an earlier empirical claim remains supportable when relevant observations are obtained again under a specified relation to the original research configuration. Within GRE, that relation often extends beyond matching a statistical estimator or survey instrument. A claim about trust, relational allocation, conversion, generativity, power, dependency, or return can depend on institutional rules, network positions, historical sequences, recognition regimes, infrastructures, and temporal horizons. A useful replication therefore identifies which of these conditions are part of the focal claim and which may vary without changing its meaning.

Definition 22.902 (Empirical replication specification). *An empirical replication specification records the original estimand or qualitative empirical claim, population and observation unit, focal relation or mechanism, measurement architecture, temporal horizon, sampling or assignment process where applicable, institutional and historical conditions, dependence and interference structure, permissible design variation, and the criteria by which the later result will be compared with the original result.*

This specification supports several forms of replication. A close replication can preserve population type, measurement, implementation, and analysis while obtaining new observations. A site replication can preserve the mechanism hypothesis while changing organization or jurisdiction. A temporal replication can revisit the same population after the surrounding institutional field has changed. A relational replication can test whether the same relation or mechanism appears through a different observable manifestation. These forms answer different questions and should not be pooled under a single binary label of replicated or unreplicated.

GRE also requires attention to relational interference. A replication can occur after the original study has changed the field, after participants have learned the intervention, after a platform has adjusted its rules, or after a policy has diffused across organizations. The later configuration can therefore be historically downstream of the earlier inquiry. A difference in results can reflect real transformation rather than instability of the original finding.

Proposition 22.903 (Relational replication condition). *An empirical replication provides a strong test of an earlier GRE claim when the later design preserves or explicitly translates the relations, mechanisms, measurement meanings, and historical conditions material to that claim, while differences in population, site, period, or implementation are documented well enough to distinguish instability of the claim from transformation of the research configuration.*

A replication result should therefore be reported as a structured comparison. Similar effect estimates can conceal different mechanisms, while different estimates can remain compatible with the same mechanism under changed enabling conditions. The comparison should preserve effect or pattern magnitude where relevant, uncertainty, sign or direction, mechanism evidence, relational configuration, implementation fidelity, and domain differences. This provides more information than a significance-based replication verdict and aligns replication with the design-indexed warrant developed in Section 22.19.

22.25.2 Historical Reinterpretation

Historical research accumulates through preservation and reinterpretation as much as through repetition. An archive can become newly accessible, a previously excluded actor can become documentable, a legal classification can be reconstructed more precisely, or a later body of research can reveal that an earlier historical category compressed distinct relations. Historical reinterpretation revisits an earlier reconstruction while preserving the difference between new knowledge about the past and knowledge that was available within the past or to the earlier researcher.

Definition 22.904 (Historical reinterpretation record). *A historical reinterpretation record links an earlier historical reconstruction to its source base, category system, temporal boundary, interpretation, and acknowledged remainder; then records newly available sources, revised provenance assessments, later concepts, alternative chronologies, newly visible positions or relations, and the resulting changes in interpretation.*

Historical reinterpretation can occur with or without new primary evidence. New evidence can alter chronology, identify omitted actors, reveal earlier institutional layers, or contradict an established narrative. A reinterpretation can also arise from a new analytical distinction applied to already preserved evidence. For example, later research can distinguish formal authority from practical mediation, nominal return from generative return, or resource inequality from a demonstrated power mechanism. The new distinction can reorganize the earlier material even though the archive itself has not changed.

The procedure requires temporal discipline. Later concepts can sharpen historical analysis, yet their use should not imply that historical participants possessed the same categories or understood their circumstances through them. The research record should therefore distinguish an actor-level historical category, an earlier scholarly category, and a later analytical category where those layers diverge.

Proposition 22.905 (Historical reinterpretation provenance condition). *A historical reinterpretation is stronger when the earlier reconstruction remains recoverable, new evidence and later analytical categories are separately identified, changes in source survival and access are documented, and revised conclusions specify whether they concern the past event itself, the earlier scholar's evidential position, or the later analytical vocabulary used to reconstruct it.*

This condition allows historical knowledge to develop without hindsight substitution. An earlier interpretation can have been reasonable relative to the evidence then available and still require substantial revision. Conversely, a later interpretation can be more richly informed while carrying new category risks. Versioned historical interpretation therefore supports both epistemic improvement and fair reconstruction of prior inquiry.

22.25.3 Cross-Cultural Reinterpretation

Cross-cultural inquiry intensifies the problem of equivalence. Economic relations that share a translated label can differ in constitutive norms, kinship structures, legal forms, institutional histories, religious meanings, linguistic distinctions, expectations of reciprocity, or boundaries between household, community, market, and state. GRE should therefore treat cross-cultural recurrence as a translation problem before it is

treated as direct replication.

Definition 22.906 (Cross-cultural reinterpretation profile). A *cross-cultural reinterpretation profile* records the source and target settings, focal concept or relation, locally operative categories and terms, relevant institutional and historical structures, translation choices, functional similarities, constitutive differences, observed manifestations, participant interpretations, unresolved translation remainders, and the scope of any resulting cross-cultural comparison.

A replicated questionnaire item does not ensure replicated meaning. A category such as household contribution, care, debt, obligation, autonomy, ownership, or participation can occupy a different relational position across settings. Likewise, a superficially different practice can perform a similar relational function. Cross-cultural research should therefore examine semantic, institutional, functional, and historical correspondence separately rather than treating linguistic translation as sufficient.

This issue is especially important for justice and power. A local normative vocabulary can contain distinctions not captured by the researcher's initial categories, while apparently consensual practices can exist within durable asymmetries that shape who can contest them. Cross-cultural reinterpretation should preserve participant meanings while retaining the possibility of external analytical critique. Neither local description nor imported universal vocabulary should automatically exhaust the object.

Proposition 22.907 (Cross-cultural comparability condition). A *cross-cultural replication or reinterpretation warrants comparative inference to the extent that the research establishes which semantic, relational, institutional, and historical structures are sufficiently corresponding for the focal claim, while preserving materially relevant differences and translation remainders that limit equivalence*.

Repeated cross-cultural work can eventually reveal families of related structures rather than one universal form. Such families can support differentiated generalization: a mechanism can recur across several cultural configurations while being realized through different institutions and meanings. Failure to establish correspondence can also be a substantive result, linking this subsection to non-transferability and negative translation in Sections 22.20 and 22.24.

22.25.4 Model Replication

Formal and computational research introduces a distinct replication problem. A reported result can depend on equations, code, numerical solvers, random seeds, data preprocessing, parameter initialization, stopping rules, software libraries, hardware, or undocumented judgment. Regenerating the same output is therefore valuable, but model replication should distinguish computational reproduction from substantive replication of the model's economic claims.

Definition 22.908 (Model replication record). A *model replication record* specifies the formal model version, equations or algorithm, code and dependency versions, data and preprocessing provenance where applicable, parameterization, initialization, numerical tolerances, stochastic seeds or seed policy, calibration and validation targets, reproduced outputs, deviations from the reported outputs, and the substantive claims that the reproduced computation is intended to support.

Exact computational reproduction can be a demanding achievement, especially for

stochastic, agent-based, optimization, or simulation models. It nevertheless answers only one question: whether the implementation can regenerate the reported output under sufficiently similar technical conditions. Substantive replication asks whether the model's qualitative behavior, empirical fit, mechanism, or comparative conclusions survive new data, alternative implementations, parameter perturbations, or another plausible formal representation.

A model can therefore be computationally reproducible and substantively fragile. Conversely, two independent implementations can differ at the level of trajectories while preserving the same robust distributional or dynamical property. The replication target should match the original claim. A claim about an attractor, transition threshold, network concentration, or comparative regime requires different tolerances and diagnostics from a claim about one exact simulated history.

Proposition 22.909 (Formal reproduction and substantive replication). *Model replication should distinguish reproduction of an implementation from replication of a substantive formal claim; confidence in the latter increases when independent implementations or data configurations preserve the claimed structure under tolerances and perturbations appropriate to that claim.*

This distinction is particularly important for the stronger formalisms considered in Section 22.17. An amplitude-like, operator-algebraic, field, or 2-complex representation can be internally reproducible while remaining weakly connected to observable economic structure. Replication should therefore retain the empirical and interpretive bridge rather than allowing technical reproducibility to substitute for substantive validation.

22.25.5 Conceptual Replication

GRE uses concepts such as relational allocation, generative return, option-space, conversion, relational power, generative exploitation, epistemic economy, and re-epistemization across multiple domains. Their cumulative value depends partly on whether later researchers can reconstruct the same analytical distinction without reducing conceptual identity to repeated terminology. Conceptual replication asks whether a concept retains its constitutive structure when applied to a new case, domain, period, or method.

Definition 22.910 (Conceptual replication profile). *A conceptual replication profile records the concept version, constitutive distinctions, required relations or mechanisms, excluded neighboring concepts, source domain, target case or domain, observable or interpretive manifestations, translation adjustments, preserved structure, lost structure, newly required qualifiers, and the resulting judgment about conceptual continuity.*

Conceptual replication is especially useful where operationalizations differ. Generative return in a research institution can appear through regenerated knowledge capacity, while generative return in ecological stewardship can appear through renewed ecological and community capability. The manifestations differ, yet the concept can remain continuous if the central relation between return and future generative capacity is preserved. Conversely, identical terminology can hide conceptual drift if one study treats return as any flow back to a source while another requires regeneration.

A concept can also develop through replication. Repeated applications can expose

omitted dimensions, reveal domain-specific subtypes, or show that a previously central feature is incidental. These changes should be versioned. Conceptual development becomes difficult to evaluate when the same label silently changes meaning across studies and apparent replication is produced by retrospective harmonization.

Proposition 22.911 (Conceptual continuity condition). *A conceptual replication supports continuity when the target application preserves the constitutive distinctions and inferential role of the concept under explicit translation, while any domain-specific additions or losses are recorded as versioned modifications rather than silently absorbed into a stable label.*

Conceptual replication therefore complements the comparative theory programme. It can reveal a family resemblance strong enough for coordinated research without implying identity across domains. It can also identify the point at which a concept should split into differentiated subtypes or remain non-transferable.

22.25.6 Failed Replication

A failed replication is a structured divergence from an earlier result under a recurrence that was sufficiently specified to make comparison meaningful. Such divergence belongs to the negative-result programme, but it has a distinctive evidential structure because two studies or reconstructions now stand in explicit relation to one another. The task is to explain which difference matters before assigning the failure to the original claim, the replication design, or a transformed research context.

Definition 22.912 (Replication-failure dossier). *A replication-failure dossier records the original result and version, replication target, expected invariants, actual design correspondence, observed divergence, measurement and implementation quality, population and contextual differences, temporal change, stochastic uncertainty, mechanism evidence, alternative explanations, and the implications of the failure for both the original and replication claims.*

Several failure types should remain distinguishable. Implementation failure occurs when the intended recurrence was not realized. Measurement failure occurs when indicators or categories cease to correspond. Sampling or population failure concerns a materially different composition. Contextual failure arises when institutions or relations differ. Temporal failure occurs when the world has changed between studies. Mechanism failure occurs when the expected causal or generative process does not recur. A claim-level failure remains after these alternatives have been investigated and the replication still supplies credible adverse evidence against the earlier claim or its stated transfer scope.

Failed replication should also avoid a temporal asymmetry that automatically privileges the first study. The original can contain design weaknesses that become visible only through later recurrence. The replication can also introduce new weaknesses. Both versions should remain open to diagnosis. Where possible, a third design or reanalysis can discriminate between them.

Proposition 22.913 (Replication-failure localization condition). *A failed replication should alter the status of an earlier claim in proportion to the demonstrated correspondence between studies and the extent to which implementation, measurement, population, contextual, temporal, stochastic, and mechanism-based explanations of divergence have been examined.*

This proposition links failed replication to the claim-indexed counterevidence architecture of Section 22.23. A failed replication can become strong counterevidence, a domain-contraction signal, a measurement warning, a negative result, or evidence of historical transformation. The research record should preserve which interpretation is currently warranted and which alternatives remain open.

22.25.7 Reanalysis under New Categories

Preserved evidence can become analytically different when the category system changes. Administrative categories can be revised, legal statuses can be redefined, social identities can be recorded differently, institutional roles can split or merge, economic activities can move between formal and informal classifications, and a research programme can introduce distinctions that were absent from the original analysis. Reanalysis under new categories can reveal hidden heterogeneity, yet it also creates risks of retrospective category imposition and broken comparability.

Definition 22.914 (Category-reanalysis protocol). A *category-reanalysis protocol* records the original category system and coding rules, later category system, reasons for revision, mapping between old and new categories, records that can and cannot be recoded, uncertainty introduced by retrospective coding, categories unavailable or unintelligible in the earlier context, changed denominators or boundaries, and the effect of recoding on the substantive conclusions.

A later category can improve analysis by separating relations previously pooled together. For example, a broad category of participation can be disaggregated into nominal access, effective voice, contestability, and decision authority. A broad category of return can be separated into nominal flow, usable return, and generative return. Such reanalysis can reveal that an earlier average concealed different relational positions.

The new category does not automatically become historically native. Researchers should record whether retrospective coding uses evidence that supports the distinction or merely projects a later taxonomy onto records too coarse to sustain it. Some older data cannot be reliably recoded because the required distinctions were never observed. In those cases, missing comparability is itself part of the result.

Proposition 22.915 (Category-shift comparability condition). *Reanalysis under a new category system supports comparison with an earlier analysis when the mapping between category versions is empirically reconstructable for the relevant records, uncertainty from retrospective coding is visible, and conclusions that depend on newly introduced distinctions are not attributed to earlier data beyond what those data can support.*

Versioned category reanalysis also provides a direct test of measurement-induced distortion from Section 22.22. If a result changes substantially after a more relationally adequate classification is introduced, the difference can reveal how the original category allocated visibility. Reanalysis can therefore revise both the empirical conclusion and the measurement architecture that produced it.

22.25.8 Longitudinal Re-Epistemization

Longitudinal re-epistemization treats knowledge states themselves as historical objects. Evidence accumulates, archives open or disappear, concepts are revised, meth-

ods improve, institutions change, and later events alter the relevance of earlier observations. A cumulative research programme therefore needs more than a latest-version conclusion. It needs a recoverable sequence showing how warranted interpretation changed and why.

Definition 22.916 (Re-epistemization trajectory). A *re-epistemization trajectory* is a versioned sequence of epistemic states in which each state records the available evidence, category system, methods, models, principal interpretations, uncertainty, counterevidence, unresolved remainders, and the event or argument that motivates transition to a later state.

The trajectory can include several kinds of transition. New data can revise an estimate. New testimony can alter the reconstruction of an institution. A new concept can make an old pattern newly visible. A failed replication can narrow a domain claim. A formal counterexample can force a weaker representation. A technological change can make an earlier mechanism obsolete. A normative development can change how a preserved economic arrangement is evaluated. These transitions differ in epistemic type and should remain identifiable.

Longitudinal re-epistemization also preserves as-of warrant. A conclusion that later becomes untenable can have been responsibly held under an earlier evidential state. Conversely, a conclusion that survives later inquiry can gain support through repeated reinterpretation and replication. Preserving the sequence allows researchers to study the conditions under which knowledge stabilized, drifted, fragmented, or was repaired.

Proposition 22.917 (Temporal epistemic versioning condition). A *longitudinal re-epistemization record* is adequate when later knowledge can revise earlier interpretations while the evidence, concepts, uncertainty, and decision-relevant warrant of each earlier epistemic state remain reconstructable on their own historical terms.

This condition gives preservation an option value. Records whose present use seems limited can become important when later questions or methods emerge. At the same time, preservation should remain governed by privacy, legal, ethical, and resource constraints. The purpose is not indiscriminate retention, but maintenance of sufficient provenance for responsible future reinterpretation.

Definition 22.918 (Replication portfolio). A *replication-reinterpretation portfolio* is a versioned collection of empirical replications, historical and cross-cultural reinterpretations, model and conceptual replications, failed replications, category reanalyses, and re-epistemization trajectories organized so that recurrence, divergence, category change, contextual transformation, and claim revision can be compared across projects.

The portfolio permits patterns that are difficult to see in individual studies. A mechanism can replicate across several settings but fail after an institutional transition. A concept can travel across domains while one measurement does not. A historical interpretation can remain stable despite new sources, while its normative evaluation changes. Several failed replications can identify a boundary condition that no single study could establish. Reinterpretation can also reveal that apparently contradictory studies were observing different manifestations of a changing configuration.

Proposition 22.919 (Cumulative replication-reinterpretation condition). *Replication and reinterpretation strengthen GRE as an open research programme when they preserve versioned provenance, expose claims and concepts to recurrence under spec-*

ified conditions, distinguish substantive instability from transformed contexts and categories, and allow later evidence to revise the programme without erasing the epistemic history through which earlier results acquired their standing.

The resulting architecture makes cumulative inquiry possible across empirical, historical, formal, conceptual, and cultural variation. Replication supplies disciplined recurrence; reinterpretation supplies disciplined revision of meaning; re-epistemization connects both through time. Their usefulness depends on durable records, comparable versions, documented disagreement, and accessible research objects. These requirements make research infrastructure the next analytical object of the chapter.

22.26 Research Infrastructure

A cumulative GRE research programme requires infrastructures that preserve more than final publications and currently preferred conclusions. The programme developed in this chapter depends on recoverable data provenance, executable or reconstructable models, historically situated archives, relational representations, versioned concepts, versioned formalizations, visible disagreement, and records that remain interpretable across generations of researchers. This section specifies research infrastructure as an epistemic and institutional object rather than as a neutral technical background. Its objective is to identify the minimum structures through which GRE claims, counterevidence, negative results, replications, reinterpretations, and later revisions can remain answerable to their own histories. The discussion proceeds across data commons, model repositories, historical archives, relational maps, versioned concepts, versioned models, open disagreement, and intergenerational research memory. The method is infrastructural and methodological: each subsection asks what must be preserved, how access and governance affect what can be known, and which losses would prevent later researchers from reconstructing the warrant of an earlier result.

Definition 22.920 (GRE infrastructure record). *A GRE infrastructure record is a maintained assemblage linking research objects to their provenance, versions, access conditions, analytical dependencies, evidential status, interpretive context, governance rules, preservation state, and documented pathways for reuse, replication, contestation, and later reinterpretation.*

Definition 22.920 treats infrastructure as part of the evidential chain. A dataset without a recoverable sampling frame, a model without executable dependencies, an archive without provenance, a relational map without construction rules, or a concept without version history can remain physically available while losing much of its research value. Conversely, a carefully documented negative result, abandoned model, disputed interpretation, or obsolete classification can retain substantial option value when later questions make its history newly relevant.

Proposition 22.921 (Infrastructure answerability condition). *Research infrastructure strengthens GRE when it preserves enough provenance, versioning, governance, and contextual information for later researchers to reconstruct what an earlier research object represented, how it was produced, which claims it supported, which limitations were known, and how subsequent use may legitimately differ from the original use.*

Table 22.26: Principal infrastructure domains in the GRE research programme

Infrastructure domain	Primary object preserved	Principal epistemic requirement
Data commons	Data, metadata, collection histories, transformations, access rules	Preserve provenance, relational meaning, uncertainty, exclusions, and conditions of legitimate reuse
Model repositories	Formal and computational models, code, parameters, dependencies, validation records	Preserve reproducibility, substantive interpretation, assumptions, and version-specific evidential standing
Historical archives	Documents, records, testimonies, classifications, institutional traces, provenance	Preserve temporal context, archival survival conditions, uncertainty, and later reinterpretability
Relational maps	Networks, hypergraphs, fields, trajectories, multilayer relations, construction rules	Preserve what relations mean, how boundaries were drawn, and which absent or uncertain ties remain unresolved
Versioned concepts	Definitions, distinctions, category systems, translation records, scope notes	Preserve conceptual change without projecting later meanings backward or erasing earlier usage
Versioned models	Model families, assumptions, calibration states, revisions, failures, retired forms	Preserve why models changed and which empirical or formal pressures motivated each revision
Open disagreement	Competing interpretations, critiques, minority positions, unresolved conflicts, responses	Preserve disagreement as attributable research information rather than compressing it into a synthetic consensus
Intergenerational research memory	Linked records across projects, institutions, personnel, and periods	Preserve sufficient continuity for later researchers to recover abandoned paths, unresolved questions, and as-of warrant

Table 22.26 summarizes the principal infrastructure domains. Their boundaries overlap intentionally. A historical archive may contain data, models may depend on relational maps, conceptual versions may determine data comparability, and open disagreement may be attached to any of these objects. The analytical task is therefore to preserve interfaces among infrastructures rather than to treat each repository as an isolated storage system.

22.26.1 Data Commons

Data commons provide a shared infrastructure for empirical material while making its production conditions visible. Within GRE, this requirement is especially important because many research objects are relational, historical, multiscale, and generated through institutions that determine what becomes observable. A table of observations detached from collection rules can conceal whether a recorded variable represents an individual attribute, a relational manifestation, an institutional classification, an administrative convenience, or a proxy whose meaning changed over time.

Definition 22.922 (GRE data-commons dossier). A *GRE data-commons dossier* links a dataset or data collection to its source institutions, population and observation units, collection period, sampling or inclusion process, relational and historical context, measurement versions, transformations, missingness, uncertainty, access restrictions, legal and ethical conditions, known exclusions, derivative datasets, and documented research uses.

A data commons can therefore contain several layers. The first is the preserved data object. The second is metadata sufficient to interpret the observations. The third is provenance showing how records were created, cleaned, recoded, merged, or excluded. The fourth records governance: who may access the material, who can authorize reuse, which communities or positions have standing over the data, and

which uses remain prohibited even when technically possible. The fifth links derived analyses back to the versions of data on which they depend.

The commons architecture should also preserve relational missingness. Missing ties, undocumented interactions, unobserved informal institutions, inaccessible groups, and erased historical records can systematically affect conclusions. A conventional missing-data code can be insufficient when absence results from power, administrative invisibility, legal exclusion, archival destruction, or the cost of observing certain relations. The infrastructure should therefore permit uncertainty about the relational field itself to remain visible.

Proposition 22.923 (Context-preserving data reuse condition). *Reuse of a GRE data object is epistemically defensible when the later analysis can identify the data version, recover the construction and measurement context material to the new claim, respect governance and ethical constraints, and distinguish newly imposed analytical categories from distinctions that the preserved observations can actually support.*

This condition makes openness conditional on intelligibility and legitimacy rather than mere downloadability. Fully unrestricted release can be inappropriate for sensitive relational, community, legal, or institutional data. A commons can therefore support tiered access, secure environments, controlled linkage, or community-governed reuse while remaining part of an open research programme in the broader sense of answerability, documented rules, and contestable decisions.

22.26.2 Model Repositories

Formal and computational research becomes difficult to reproduce when only final equations, plots, or summary parameters survive. The formal research programme in Section 22.17 includes dynamical, stochastic, network, field, algebraic, geometric, agent-based, operator-algebraic, partial-order, history-kernel, and amplitude-like representations. These model families impose different assumptions and require different kinds of supporting artifacts. A model repository should preserve the representational and evidential state in which a result was obtained.

Definition 22.924 (Model-repository package). *A model-repository package contains the formal specification or code required to reconstruct a model version together with its assumptions, variables and object meanings, parameter provenance, software and dependency environment where applicable, initialization and boundary conditions, calibration or estimation procedure, validation record, sensitivity analyses, known failures, empirical interfaces, and links to later or earlier model versions.*

Executable reproducibility is one layer of this package. Substantive reproducibility is another. Code can execute successfully while implementing a representation whose economic interpretation has been lost. A network model, for example, can reproduce a reported statistic while later users no longer know whether an edge represented contractual exchange, communication, recognition, dependence, or inferred co-occurrence. A field model can run while the relation between the field variable and observable economic manifestations remains undocumented. Preservation should therefore bind computational objects to their analytical semantics.

Repositories should also preserve failed and retired models. A model abandoned because of non-identification, instability, representational loss, poor validation, or excessive complexity can constrain future inquiry by showing which paths have already been tested. Deleting such versions leaves later researchers vulnerable to rediscover-

ing the same failure without knowing its earlier conditions.

Proposition 22.925 (Model reconstruction condition). *A preserved model supports cumulative formal inquiry when a later researcher can reconstruct both the model's computational or mathematical behavior and the substantive interpretation, assumptions, empirical bridge, validation state, and known failure conditions attached to the specific version being used.*

This proposition supports repositories that treat models as versioned research objects rather than timeless formulas. A later implementation can improve numerical performance or software quality without inheriting the same empirical standing. Conversely, an older implementation can remain scientifically important because it preserves the assumptions against which a later revision should be compared.

22.26.3 Historical Archives

Historical infrastructure must preserve evidence together with the history of its survival and classification. The historical and interpretive programme in Section 22.18 depends on records whose availability is itself historically produced. Administrative documents may overrepresent formal authority; institutional archives may preserve official decisions while losing informal mediation; community knowledge can survive through testimony rather than standardized records; records of excluded positions may never have been generated. A research archive should therefore make archival formation visible where possible.

Definition 22.926 (Historically situated archive record). *A historically situated archive record links preserved material to its creator or source position, creation date or period, original function, custody and transfer history, classification history, preservation or loss conditions, access restrictions, later digitization or transcription, known gaps, contested provenance, and research interpretations attached to identifiable versions of the record.*

Such records allow researchers to distinguish absence in the archive from absence in the historical world. They also support reinterpretation when later evidence changes the significance of an existing document. Digitization can increase access while simultaneously stripping material context, original ordering, marginalia, physical relationships among documents, or evidence of institutional filing practices. Infrastructure design should therefore preserve links between digital surrogates and archival context where those features matter.

Historical archives also benefit from layered annotations rather than irreversible correction. A transcription error can be corrected while retaining the earlier version and reason for revision. A disputed date can carry competing interpretations. A later classification can be added without overwriting the original category. This architecture allows historical re-epistemization to occur through additions and versioned reinterpretation rather than through silent normalization of the past.

Proposition 22.927 (Archival re-interpretability condition). *A historical archive supports longitudinal GRE inquiry when preserved materials retain sufficient provenance, ordering, classification history, uncertainty, and annotation versioning for later researchers to distinguish the historical record from subsequent editorial and analytical interventions.*

The condition does not require infinite preservation. Resource, legal, privacy, cul-

tural, and ethical constraints can justify selective retention or restricted access. It requires that selection and restriction themselves be documented when they materially shape the evidential field available to future inquiry.

22.26.4 Relational Maps

Relational maps are infrastructures for preserving configurations whose analytical meaning lies partly in relations among positions rather than in isolated records. They can include networks, hypergraphs, affiliation structures, higher-order relations, spatial and temporal paths, value-circulation traces, institutional layers, dependency structures, and partially ordered event histories. Their usefulness depends on preserving the rules by which the map was constructed.

Definition 22.928 (Relational-map provenance record). *A relational-map provenance record specifies the represented positions or entities, relation types, direction and multiplicity where relevant, boundary rules, temporal resolution, scale, data sources, inference procedures, uncertainty, missing or censored relations, aggregation transformations, map version, and the claims for which the representation was constructed.*

Relational maps can otherwise generate false stability. Node identifiers may persist while the entity represented by a node changes. A relation type can be recoded across periods. A platform redesign can change the meaning of an observed interaction. A community boundary can shift. Aggregation can turn a heterogeneous higher-order relation into a pairwise edge. The infrastructure should therefore preserve map semantics alongside topology.

Maps should also permit plural representations of the same empirical field. A contractual map, communication map, recognition map, ownership map, knowledge-flow map, and dependency map may all describe overlapping positions while making different relations visible. Forcing them into one universal graph can erase the typed structure required for analysis. Infrastructure can instead link representations through documented correspondences and remainders.

Proposition 22.929 (Relational-map comparability condition). *Two relational maps support substantive comparison when the relation types, position identities, boundary rules, temporal and scale resolutions, and construction procedures relevant to the comparison are either preserved or explicitly translated, and when unmatched structures remain visible as comparison remainders.*

This condition also applies to longitudinal maps. A changing network can represent genuine relational transformation, changed observability, changed classification, or a mixture of these. Versioned provenance makes those possibilities empirically distinguishable to the extent permitted by the evidence.

22.26.5 Versioned Concepts

GRE concepts are expected to remain revisable. Concepts such as relation, generativity, value conversion, return, power, justice, exploitation, epistemic capacity, or option space can acquire sharper distinctions, narrower domains, or different operational interfaces as inquiry develops. Research infrastructure should preserve these changes rather than treating the latest definition as though it had governed every earlier study.

Definition 22.930 (Concept-version record). A *concept-version record* identifies a concept version, its definition or constitutive distinctions, scope, relation to neighboring concepts, measurement or interpretive interfaces, known ambiguities, motivating evidence or argument, predecessor and successor versions, translation rules where available, and studies whose claims depend materially on that version.

Versioning permits conceptual refinement without retrospective homogenization. If an early study used a broad notion of generative return and a later version distinguishes nominal return, usable return, and capacity-regenerating return, the earlier result can be reanalyzed without pretending that the distinctions were already encoded in its original claims. The record can identify which findings survive under the new concept, which become ambiguous, and which cannot be recoded from the preserved evidence.

Conceptual versioning should also preserve abandoned distinctions. A concept can be retired because it duplicates another term, fails to travel across domains, creates measurement confusion, or carries unsupported ontological implications. Recording the reason for retirement turns conceptual failure into reusable research knowledge.

Proposition 22.931 (Conceptual version integrity condition). A *versioned concept supports cumulative inquiry when claims remain attributable to the concept version under which they were formulated, later revisions are linked to their motivating reasons, and translation into a new version does not silently attribute distinctions or scope to earlier evidence that the earlier research could not sustain.*

This infrastructure is especially important for cross-domain work. A concept can retain a shared structural core while developing domain-specific variants. Version records can preserve both the common lineage and the local remainder, reducing pressure to choose prematurely between universalization and fragmentation.

22.26.6 Versioned Models

Model versioning extends beyond source-control history. A later model can alter assumptions, state variables, topology, parameters, calibration data, causal interpretation, objective functions, stochastic structure, or empirical domain. These changes can improve one research task while weakening comparability with an earlier result. Infrastructure should therefore record model lineage at the level of scientific commitments.

Definition 22.932 (Scientific model-version record). A *scientific model-version record* specifies the mathematical or computational version, substantive assumptions, represented objects and relations, parameters and data dependencies, empirical target, validation status, known counterexamples and failures, changes from the preceding version, reason for those changes, and the set of claims that should or should not be compared across versions.

A model family can then be represented as a branching lineage rather than a single improving sequence. One branch may increase empirical tractability by simplifying relational structure. Another may preserve higher-order relations at greater computational cost. A third may explore a stronger formal analogy with explicitly limited empirical claims. Branching allows several research purposes to coexist without implying that the numerically latest model supersedes every earlier representation.

Versioning also supports rollback. A newly complex model can later be judged

unhelpful if additional assumptions fail to improve discrimination or empirical correspondence. Returning to a simpler version can be a scientifically informed move rather than a loss of progress when the repository preserves the reasons for both extension and retreat.

Proposition 22.933 (Model-lineage accountability condition). *Model development remains accountable when each substantive revision is attributable to an identified formal, empirical, interpretive, or practical pressure and when the consequences of the revision for comparability, scope, validation, and claim strength remain recoverable across the model lineage.*

Versioned model infrastructure therefore links directly to counterevidence and negative results. Failed versions, domain contractions, altered mechanisms, and changed formal assumptions can be studied as part of the programme's epistemic development rather than hidden behind a final polished model.

22.26.7 Open Disagreement

Cumulative research also requires infrastructure for preserving disagreement. Conventional publication and synthesis practices can compress multiple positions into a consensus statement or leave critiques dispersed across documents that later researchers cannot reconstruct. GRE's commitments to theoretical pluralism, negative translation, counterevidence, and reinterpretation make unresolved disagreement itself a research object.

Definition 22.934 (Open-disagreement record). *An open-disagreement record links a disputed claim, concept, interpretation, model, measurement, or normative premise to identifiable positions, supporting evidence and arguments, replies, points of agreement, points of unresolved conflict, conflict type, changes through time, and conditions that participants or later researchers regard as potentially discriminating.*

The record should distinguish disagreement types developed in the comparative-theory programme. Empirical disagreement can turn on evidence or identification. Mechanistic disagreement can concern causal pathways. Representational disagreement can concern what a model preserves. Historical disagreement can concern chronology, provenance, or category use. Normative disagreement can concern principles that additional data alone will not settle. Constitutive disagreement can concern what object is being studied. Infrastructure that records these differences prevents all conflict from being treated as a single unresolved opinion gap.

Open disagreement also requires attribution. A minority position should not be preserved only as an anonymous objection if its evidential or conceptual lineage matters. At the same time, infrastructure should avoid converting disagreement into reputational scoring. The object is the research conflict and its evolution, not a ranking of persons.

Proposition 22.935 (Disagreement preservation condition). *A disagreement is productively preserved when later researchers can reconstruct the competing claims, their evidential and conceptual bases, the type of conflict involved, responses and revisions, and the conditions under which the disagreement was narrowed, transformed, or left unresolved.*

Such records can reduce false consensus and repetitive controversy. They can also reveal that an apparent disagreement dissolved after categories were clari-

fied, while another persisted because the underlying normative premises differed. Preserving both outcomes supports more precise theoretical dialogue and later re-epistemization.

22.26.8 Intergenerational Research Memory

The longest horizon of research infrastructure concerns memory across generations of researchers, institutions, and technological systems. Personnel change, organizations close, formats become obsolete, software dependencies disappear, languages shift, legal regimes change, and present research priorities can make earlier records seem irrelevant. Yet Chapters 21 and 22 repeatedly identify option value in theoretical remainders, negative results, historical archives, failed models, unresolved disagreement, and records whose later significance could not have been predicted when they were created.

Definition 22.936 (Intergenerational research-memory system). An *intergenerational research-memory system* is a governed infrastructure that preserves linked research objects, provenance, conceptual and model lineages, unresolved questions, negative and positive results, access and ethical conditions, migration histories, and interpretive guidance across changes in personnel, institutions, formats, and research generations.

Intergenerational memory has at least four requirements. The first is technical continuity: formats, code, identifiers, and metadata should remain migratable. The second is semantic continuity: future researchers need enough explanation to understand what an object meant in its original analytical and institutional context. The third is governance continuity: rights, restrictions, community standing, privacy obligations, and stewardship commitments should survive institutional turnover rather than disappear when a project ends. The fourth is epistemic continuity: abandoned questions, unresolved disagreements, and as-of knowledge states should remain recoverable even when current research has moved elsewhere.

Preservation necessarily involves selection. Indiscriminate retention can impose financial, ecological, privacy, security, and interpretive costs. A GRE research programme therefore requires explicit preservation criteria. These can include irreproducibility of the source material, relevance to unresolved claims, evidential uniqueness, value for longitudinal reconstruction, importance for affected communities, option value for reanalysis, and the cost or risk of retention. The criteria themselves should remain revisable and documented.

Intergenerational memory also depends on institutional redundancy. A record preserved in one laboratory, proprietary service, individual account, or national repository can remain vulnerable to organizational closure, platform change, political restriction, or technological obsolescence. Replicated stewardship across institutions or jurisdictions can increase resilience when consistent with legal, ethical, and security constraints. Redundancy should preserve governance metadata together with the research objects so that copies do not become detached from obligations attached to their use.

Proposition 22.937 (Intergenerational recoverability condition). *Research memory remains intergenerationally useful when later researchers can recover both the preserved object and the provenance, semantic context, governance obligations, epistemic status, and version history required to determine what questions the object can respon-*

sibly answer in a later research environment.

Definition 22.938 (GRE infrastructure portfolio). A *GRE infrastructure portfolio* is a coordinated, versioned collection of data commons, model repositories, historical archives, relational maps, concept and model lineages, disagreement records, and intergenerational memory systems whose interfaces allow research objects and claims to remain traceable across empirical, historical, formal, interpretive, and applied inquiry.

The portfolio makes infrastructure itself assessable. Researchers can ask where provenance is weak, which concepts lack version links, which models are no longer executable, which archives systematically omit affected positions, which relational maps cannot be compared across time, which disagreements have been prematurely closed, and which records are approaching technological or institutional obsolescence. Infrastructure debt can thereby be identified alongside theoretical and methodological debt.

Proposition 22.939 (Cumulative infrastructure condition). *Research infrastructure supports a cumulative and revisable GRE programme when it preserves the relations among research objects, evidence, concepts, models, disagreements, governance obligations, and historical versions well enough for future inquiry to reproduce, contest, reinterpret, and responsibly transform earlier work without requiring the earlier research environment to remain unchanged.*

Research infrastructure therefore serves as a temporal and relational substrate for the programme rather than a final storage layer. It keeps empirical material connected to provenance, formal objects connected to assumptions, concepts connected to their histories, disagreement connected to identifiable reasons, and preservation connected to governance. With that substrate in place, Chapter 22 can close by asking which GRE findings can enter cross-domain dialogue, which structures remain candidates for wider Generative Relational inquiry, and which results should remain explicitly economic or non-transferable.

22.27 Cross-Domain Interfaces of the GRE Research Programme

The research programme developed across this chapter remains an economic programme even when its findings create questions that economics cannot settle internally. Historical reconstruction can reveal economic path dependence without supplying a general philosophy of history. Analysis of economic power can identify dependence, constrained alternatives, and control over conversion or circulation without settling questions of political legitimacy. Relational allocation can show how resources alter capabilities and relations without determining the legal form through which claims should be recognized. Ecological, educational, epistemic, aesthetic, and artificial-intelligence questions can enter GRE where economic structures condition them, while their domain-specific objects continue to require forms of inquiry that exceed economics. This final section specifies the research interface through which such results can leave GRE without being redescribed prematurely as general Generative Relational conclusions. Its objective is to distinguish domain-specific findings, candidate cross-domain structures, non-transferable results, and research questions that should be handed to neighboring programmes. The discussion proceeds through

Generative Relational History (GRH), Generative Relational Governance (GRG), Generative Relational Law (GR-Law), other neighboring domains, and a closing domain-interface agenda. The method is comparative and programmatic: cross-domain generalization is treated as a research problem whose warrant must be earned through translation, counterexample, and domain-specific correction.

Definition 22.940 (GRE cross-domain interface record). A *GRE cross-domain interface record* links an economic finding to the GRE claim from which it arises, its evidential and methodological warrant, the domain-specific meanings of its principal concepts, the candidate structure proposed for comparison elsewhere, the target neighboring domain, anticipated translation losses, known non-transferable conditions, questions requiring domain-specific inquiry, and the possible ways in which results from that neighboring domain could revise the originating economic claim.

Definition 22.940 makes the interface bidirectional. GRE can export a question, distinction, mechanism, or formal candidate, but the receiving domain is not required to preserve the economic meaning of the object. A structure that appears recurrent across economic cases becomes cross-domain only after the target domain establishes that the relevant objects, relations, temporal organization, values, and evidential standards remain sufficiently comparable. Feedback can then return in the opposite direction. A legal analysis may show that an apparent economic control relation depends on distinctions among ownership, authority, duty, and standing that GRE had compressed. Historical inquiry may show that an economic category treated as stable is specific to one period. Educational or ecological inquiry may reveal forms of generativity that are not captured adequately by economic value or capability measures. Cross-domain work therefore enlarges the programme partly by correcting the boundaries of economic explanation.

Proposition 22.941 (Cross-domain generalization condition). A *GRE finding warrants treatment as a candidate cross-domain structure only when its economic formulation is sufficiently explicit to be tested outside economics, the proposed correspondence does not depend on silently replacing target-domain objects with economic proxies, relevant translation losses are recorded, and failure of the correspondence is allowed to narrow or defeat the proposed generalization.*

Table 22.27 summarizes the principal operations developed below. The table does not rank neighboring domains or prescribe a common sequence. An interface can begin from a concrete empirical anomaly, a failed concept transfer, a formal resemblance, a normative remainder, or a question that GRE identifies but lacks disciplinary authority to answer.

22.27.1 Domain-Specific Findings

Cross-domain inquiry begins by preserving the specificity of the originating economic result. A finding about allocation, value conversion, circulation, generative return, power, justice, exploitation, epistemic economy, AI-mediated capability, or institutional dynamics should not acquire wider status merely because its vocabulary sounds general. The research streams in Sections 22.3–22.16 already require explicit boundaries, manifestations, mechanisms, scales, horizons, and evidential conditions. Those conditions remain part of the finding when it is proposed for use elsewhere.

Definition 22.942 (Domain-specific finding profile). A *domain-specific finding profile* records an economic result together with its object, relation types, relevant actors

Table 22.27: Principal operations in the GRE cross-domain interface programme

Interface operation	Primary research object	Principal discipline
Domain-specific findings	Economic claims with explicit local warrant and boundaries	Preserve what GRE has actually established before attempting broader translation
Candidate cross-domain structures	Recurrent relational, generative, temporal, or institutional patterns	Treat recurrence as a hypothesis for comparison rather than as evidence of a general theory
Non-transferable results	Failed mappings, domain-specific concepts, incompatible evidential or normative structures	Preserve non-translation and use it to refine both domain boundaries and candidate generalizations
GRH interface	Historical generation, path dependence, temporal depth, multiscale change, re-epistemization	Export economic questions while allowing historical inquiry to reconstruct categories and temporal structures independently
GRG interface	Governance of economic relations, response times, participation, adaptation, authority, collective coordination	Distinguish economic diagnosis from governance design, legitimacy, and institutional authority
GR-Law interface	Property, contract, status, rights, duties, recognition, legal infrastructure	Distinguish economic control and dependence from juridical categories and legal normativity
Other GR interfaces	Education, ecology, political theory, social theory, aesthetics, AI studies, and further domains	Identify economic conditions and candidate correspondences without reducing target-domain objects to economic value
Domain-interface agenda	Versioned records of exports, imports, failures, corrections, and unresolved questions	Keep cross-domain inquiry cumulative, reversible, and capable of revising GRE itself

or positions, historical and institutional setting, scale, temporal horizon, value structure, mechanism or interpretation, evidence, uncertainty, claim status, and known boundary conditions.

The profile prevents an important form of conceptual inflation. Suppose research finds that control over a value-conversion interface can create persistent economic dependence under specified institutional conditions. The economic result can motivate questions about legal, political, educational, or epistemic control, but the finding does not yet establish that all such domains contain the same type of interface or dependence. Likewise, evidence that generative return is important for maintaining a community-based economic arrangement does not establish that every regenerative process across biology, education, culture, or ecology should be modeled as an economic return flow.

Domain specificity also applies to negative findings. If a GRE construct performs poorly in one economic sector, period, or institutional form, that result should remain attached to the domain in which the failure was observed. Section 22.24 treated non-transferable concepts and other negative results as research objects. The same discipline applies at the boundary of economics. A failed economic application can be evidence against a proposed cross-domain structure, but it need not invalidate a differently constituted object in another field.

Proposition 22.943 (Domain-first interface condition). *Cross-domain inquiry should preserve the strongest defensible domain-specific statement of a GRE result before generalizing it. The exported object is the documented finding with its boundary conditions, not an abstracted slogan obtained by deleting the conditions under which the finding was established.*

This condition keeps the cross-domain programme compatible with the claim-status architecture of Section 22.2. An established argument within the book, an empirical hypothesis, a formal illustration, and an open conjecture remain different objects when they leave economics. Cross-domain circulation does not upgrade their epistemic status.

22.27.2 Candidate Cross-Domain Structures

GRE nevertheless produces structures that may warrant comparison across domains. Relational configurations, generative capacity, constraint, historical dependence, heterogeneous value, conversion interfaces, circulation, return, multiscale dynamics, asymmetry, mediation, institutional stabilization, and versioned re-epistemization can each appear outside strictly economic inquiry. Their recurrence creates a research opportunity. It does not by itself establish a universal structure.

Definition 22.944 (Candidate cross-domain structure). A *candidate cross-domain structure* is a relation, generative pattern, temporal organization, constraint architecture, transformation, or evidential form identified in GRE whose abstract specification can be compared with independently constituted objects in one or more neighboring domains without presupposing that the compared objects are identical.

The relevant abstraction should be minimal enough to permit comparison and rich enough to preserve the feature that motivated the comparison. A relational structure cannot be generalized merely as “things are connected.” A conversion interface should identify what changes form, which conditions enable the change, and which losses or asymmetries matter. A fast-slow description should identify variables or processes, characteristic timescales, coupling, and evidence for separation rather than importing the language of dynamics metaphorically. A candidate invariant should specify the transformation under which the proposed structure is expected to remain recognizable.

This creates a useful ladder of cross-domain claims. The weakest claim is analogy: two domains display a resemblance that may assist inquiry. A stronger claim concerns role or functional correspondence. Stronger still is structural correspondence under an explicit mapping. In some formal settings, a homomorphism, partial equivalence, or invariant may be proposed. Identity is a much stronger claim and should be rare. The ladder is not a ranking of intellectual value. An informative analogy can remain useful where stronger mapping would erase domain-specific meaning.

Proposition 22.945 (Cross-domain escalation condition). A *cross-domain claim* should move from analogy toward functional, structural, formal, or invariant correspondence only when the additional claim preserves the relevant objects and relations in each domain, survives domain-specific counterexamples, and contributes explanatory or research leverage beyond the weaker comparison.

The comparative-theory and replication programmes developed in Sections 22.20 and 22.25 supply useful disciplines here. Candidate structures can be translated, tested in different cases, reinterpreted under different categories, and allowed to fail. Cross-domain comparison therefore becomes one more site at which GRE can discover the limits of its own concepts.

22.27.3 Non-Transferable Results

Some results should stop at the domain boundary. Non-transferability can arise because the target domain constitutes different subjects, recognizes different forms of value, organizes evidence differently, contains distinct normative requirements, or uses a superficially similar concept for another function. It can also arise because the economic construct itself depended on institutions that have no relevant analogue elsewhere. Preserving these failures is necessary if cross-domain work is to avoid

conceptual imperialism.

Definition 22.946 (Cross-domain non-transfer record). A *cross-domain non-transfer record* documents an attempted mapping from a GRE concept, mechanism, or formal structure to another domain, the correspondence that was expected, the point at which the mapping failed, the target-domain distinction that would be lost by continuing the translation, and the consequences of the failure for both the proposed generalization and the originating GRE concept.

Non-transfer can take several forms. A concept can lack an adequate target object. A target concept can possess normative or institutional content absent from the economic source. The mapping can preserve labels while altering causal roles. A formal representation can be mathematically portable while its variables lose defensible interpretation. A proposed common metric can destroy value plurality. A domain can also contain relations for which economic exchange, allocation, production, or capability language is simply the wrong primary vocabulary.

The appropriate response is not necessarily to build a more abstract concept capable of containing everything. Abstraction can be useful when it identifies a genuinely shared structure, but it can also turn substantive disagreement into terminological compatibility. The negative-result architecture of Section 22.24 suggests another possibility: retain the failed transfer as evidence about the boundary of the concept.

Proposition 22.947 (Productive non-transfer condition). A *failed cross-domain translation contributes positively to the GRE research programme when it identifies a material domain-specific remainder; narrows a proposed generalization, reveals an unsupported assumption in the economic source concept, or specifies the additional inquiry required before comparison can resume.*

A programme capable of recording non-transfer is better positioned to contribute eventually to broader Generative Relational theorizing than one that obtains apparent unity by deleting recalcitrant differences. Generalization should emerge from repeated comparisons that survive the possibility of failure.

22.27.4 Historical Interface with GRH

Generative Relational History provides one of the nearest interfaces because GRE repeatedly depends on historical generation, path dependence, temporal depth, institutional transformation, multiple timescales, and retrospective re-epistemization. The historical and interpretive programme in Section 22.18 equips GRE to reconstruct economic histories, but it does not turn GRE into a general theory of historical becoming. The interface with GRH should therefore begin from questions generated by economic research and allow historical inquiry to reconstruct the relevant temporal objects independently.

Definition 22.948 (GRE–GRH interface dossier). A *GRE–GRH interface dossier* records an economic structure or claim whose explanation depends materially on historical generation, the historical categories and periods implicated, the temporal scales and transitions identified by GRE, the historical evidence already available, unresolved questions about sequence or contingency, and the ways in which a GRH reconstruction could confirm, differentiate, or revise the economic account.

Several research questions follow. When does an economic relation become historically persistent rather than merely recurrent? Which institutions carry effects

across generations? How should periods be delimited when the relevant processes operate on different clocks? Under what conditions is path dependence an adequate description, and when does a stronger account of structural transition become necessary? How should a later conceptual vocabulary be used without projecting meanings backward? Which economic categories are themselves products of historically specific classification regimes?

GRH can also test the temporal assumptions of GRE formalizations. A fast-slow model, transition kernel, attractor-like description, or partially ordered history can be useful only if the historical organization represented by the model is independently defensible. Historical work can identify event sequences that violate assumed scale separation, reveal institutions omitted from the state description, or show that what appears to be one persistent relation actually consists of several historically different forms.

Proposition 22.949 (Historical interface reciprocity). *The GRE-GRH interface is productive when GRE supplies explicit economic objects and temporal hypotheses for historical investigation, while GRH remains able to revise the periodization, categories, causal sequence, and historical identity of those objects rather than serving only as contextual confirmation of an economic model.*

Earlier GRH formulations can therefore function as sources of hypotheses and conceptual inheritance without becoming canonical GRE commitments. The cross-domain record should preserve which elements were inherited, which were weakened or reformulated, and which historical findings require new economic analysis.

22.27.5 Governance Interface with GRG

GRE frequently identifies conditions that generate governance problems. Persistent asymmetry, blocked circulation, exploitative return structures, temporal mismatch, infrastructural dependence, institutional lock-in, AI-mediated capability concentration, and failures of participation can all imply that uncoordinated economic adjustment is unlikely to resolve the underlying relation. GRE can diagnose these economic structures and evaluate economic consequences. Questions of legitimate authority, collective rule formation, institutional mandate, accountability, and governance design require a neighboring programme with a different principal problem-space.

Definition 22.950 (GRE-GRG interface dossier). *A GRE-GRG interface dossier records an economic configuration that generates a governance question, the positions and dependencies affected, the mechanisms and timescales identified economically, the available economic interventions and their limits, unresolved questions of authority or coordination, and the feedback that alternative governance arrangements could produce in the economic configuration.*

The distinction matters because economic desirability and governance legitimacy are not equivalent. A policy may improve a measured economic outcome while relying on authority that lacks adequate standing or participation. A governance procedure can be legitimate yet economically ineffective. A technically efficient response can operate on a timescale too fast for institutional learning or too slow for a rapidly changing economic field. GRG should therefore investigate the institutional capacities through which rules are generated, contested, revised, and maintained, while GRE studies how those arrangements interact with allocation, production, value, dependency, and capability.

The fast-slow research programme in Section 22.10 creates a particularly important interface. Economic systems can contain high-frequency price, trading, platform, or information processes alongside slower organizational, legal, educational, ecological, and trust-forming processes. GRE can identify temporal mismatch and economic consequences. The question of how institutions should coordinate across such frequencies belongs to governance inquiry and should not be answered solely by optimizing an economic objective.

Proposition 22.951 (Governance deferral condition). *A GRE result should be handed to GRG when answering the next research question requires a theory of legitimate collective authority, rule formation, institutional coordination, participation, accountability, or governance adaptation that cannot be derived from the economic effects alone.*

Deferral does not end the economic inquiry. Governance choices alter incentives, capabilities, institutions, access, and relational fields; their consequences return to GRE as new economic objects. The interface is therefore iterative rather than a one-way division of labor.

22.27.6 Legal Interface with GR-Law

Economic relations are frequently constituted or stabilized through legal categories. Property, contract, organizational personality, rights, duties, fiduciary obligations, licenses, public authority, liability, procedural standing, and legal recognition can determine who is able to control resources, enter relations, contest decisions, transfer claims, or receive remedies. GRE can study the economic effects of these arrangements, but legal status is not reducible to a bundle of economic incentives or observed control.

Definition 22.952 (GRE-GR-Law interface dossier). *A GRE-GR-Law interface dossier records an economic relation whose constitution or transformation depends materially on legal categories or institutions, the economic manifestation at issue, the relevant legal statuses and normative relations, uncertainties about legal interpretation or standing, and the economic consequences that alternative legal constructions could generate.*

Several distinctions become research priorities. Economic control can diverge from legal ownership. Contractual agreement can coexist with substantial asymmetry in bargaining power or effective exit. An economically important participant can lack legal personhood or standing. A resource can be economically valuable while its legal status limits alienation, transfer, use, or exclusion. Rights and duties can generate economic capacities without being justified by their economic consequences. Legal recognition can also create new economic subjects or relations rather than merely codifying pre-existing market facts.

The justice and exploitation programmes in Sections 22.12 and 22.13 further demonstrate why the legal interface requires restraint. A GRE diagnosis of generative exploitation does not itself determine the appropriate legal cause of action or remedy. A finding of relational or transfer injustice does not establish that a legal right exists. Conversely, the absence of legal prohibition does not settle the economic or normative evaluation. GR-Law must reconstruct the juridical architecture through its own sources, interpretive practices, and normative commitments.

Proposition 22.953 (Legal non-reduction condition). *GRE should treat a legal category as more than an economic proxy whenever the category possesses constitutive,*

normative, procedural, or institutional content whose legal meaning affects the relation under study. Economic analysis may investigate consequences and dependencies without claiming to exhaust the juridical object.

The return flow is equally important. Legal analysis can reveal that GRE has grouped economically similar cases that are legally heterogeneous, or separated cases whose legal structure generates a common economic mechanism. Such corrections should update the economic research record rather than remain external commentary.

22.27.7 Other GR Domain Interfaces

The same interface discipline applies beyond history, governance, and law. Education, ecology, political theory, social theory, aesthetics, AI studies, and other possible Generative Relational domains can each receive questions from GRE while returning distinctions that economics needs. The common task is to identify the economic conditioning of a phenomenon without inferring that the phenomenon is therefore fundamentally economic.

Definition 22.954 (Neighboring-domain question packet). A *neighboring-domain question packet* specifies an economic finding or unresolved mechanism, the target domain, the domain-specific object that requires further inquiry, the economic variables or relations that should remain visible, the concepts that should not be presumed equivalent, and the forms of feedback that could modify GRE.

For education, GRE can investigate resource allocation, access, institutional capacity, labor conditions, epistemic infrastructure, and the economic reproduction of learning opportunities. Educational inquiry must still determine what learning, curiosity, pedagogical relation, formation, and educational flourishing mean within that domain. A capability increase measured economically does not exhaust educational generativity.

For ecology, GRE can study resource flows, social metabolism, economic dependence on ecological systems, stewardship incentives, externalization, intergenerational allocation, and the economic consequences of ecological constraints. Ecological inquiry can challenge the subject boundaries, timescales, value categories, and commensurability assumptions of economics. Non-human relations and ecological integrity may require representations whose significance does not reduce to human willingness to pay or productive contribution.

For political theory and social theory, economic power, institutions, participation, collective action, social reproduction, identity, and cultural meaning create interface questions. GRE can identify economic dependencies and material conditions while leaving legitimacy, authority, collective identity, and non-economic social relations open to domain-specific theory. For aesthetics, the epistemic-economy programme can investigate the economic conditions under which attention, salience, curiosity, and aesthetic judgment are supported or crowded out, while aesthetic value and judgment remain more than market preferences. AI studies similarly require distinctions among economic capability, technical architecture, agency, epistemic participation, social meaning, and possible heterogeneous subjecthood.

Proposition 22.955 (Neighboring-domain containment condition). *GRE contributes to a neighboring domain when it clarifies economic conditions, constraints, dependencies, value pathways, or institutional consequences while leaving target-domain objects*

open to correction by that domain's evidence, concepts, methods, and normative standards.

This condition permits substantive cross-domain work without requiring rigid disciplinary isolation. The boundary is determined by principal problem-space and accountability rather than by a prohibition on shared objects.

22.27.8 Domain-Interface Agenda

The chapter can now close by converting cross-domain interfaces into a cumulative agenda. The relevant research object is not a list of neighboring disciplines. It is the history of proposed exports, imports, translations, failures, corrections, and unresolved questions generated as GRE encounters those domains. Research infrastructure developed in Section 22.26 should therefore preserve interface records alongside datasets, models, archives, concepts, disagreements, and negative results.

Definition 22.956 (GRE domain-interface agenda). *A GRE domain-interface agenda is a versioned portfolio of domain-specific findings proposed for external comparison, candidate cross-domain structures, non-transfer records, questions transferred to neighboring programmes, corrections imported back into GRE, unresolved boundary disputes, and conditions under which a broader generalization may later be reconsidered.*

The agenda can support at least four research movements. First, it can identify repeated structures worthy of comparison across independent domain studies. Second, it can identify concepts that repeatedly fail to transfer and should remain domain-specific. Third, it can locate research questions that require joint projects because neither domain can reconstruct the object adequately alone. Fourth, it can record corrections that force GRE to revise its categories, boundaries, formal models, or normative assumptions.

A broader Generative Relational theory, if one eventually becomes defensible, should therefore arise from comparison among developed domain programmes rather than from treating GRE as its template. Candidate invariants should survive heterogeneous domains, failed translations, and counterexamples. Shared formalism should follow demonstrated structural correspondence rather than motivate it by itself. Domain-specific remainder is not noise to be eliminated; it is evidence about the scope of any proposed generalization.

Proposition 22.957 (Domain-comparison prior to general-theory condition). *A broader Generative Relational generalization should be considered only after independently developed domain programmes provide sufficiently explicit objects for comparison, candidate correspondences have survived domain-specific counterevidence, non-transferable assumptions remain visible, and the proposed generalization adds explanatory or research capacity without erasing the distinctions that made the domains informative.*

The agenda should also remain open to asymmetric exchange. GRE may export a mature economic distinction into one domain while importing a more mature historical, legal, educational, ecological, or governance concept from another. There is no requirement that every interface become reciprocal at the same time or converge on a common vocabulary. What matters is that the exchange remains attributable, revisable, and capable of producing correction.

Proposition 22.958 (Cross-domain answerability of the GRE research programme). *The GRE research programme remains cross-domain answerable when it can state which results are economically warranted, which wider structures are only candidates, where translation has failed, which questions have been transferred to neighboring domains, what corrections have returned, and which claims would have to change if those neighboring inquiries produce contrary results.*

Proposition 22.958 closes the chapter at its opening epistemic commitment. GRE becomes cumulative through explicit claims, evidence, counterevidence, negative results, replication, infrastructure, and revision; cross-domain responsibility additionally requires that its boundaries remain contestable without licensing disciplinary expansion. The next chapter examines these interfaces in detail: GRE's exports and imports, non-equivalent concepts, boundary disputes, and conditions under which cross-domain comparison might support broader theorizing.

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Chapter 23

Interfaces with Neighboring Generative Relational Domains

Domain Interfaces and Disciplinary Return

Chapter 23 examines the boundary conditions under which Generative Relational Economics (GRE) can enter sustained inquiry with neighboring Generative Relational domains and established disciplines without converting disciplinary contact into conceptual absorption. Chapter 22 ended by specifying a research-programme interface through which economic findings can generate questions for history, governance, law, education, ecology, political theory, social theory, aesthetics, artificial-intelligence studies, and other domains. The present chapter develops that interface into a disciplinary architecture. Its central concern is the relation among domain identity, translation, non-translation, mutual correction, and the possibility of later cross-domain comparison.

The chapter proceeds from a restrained premise. A relation, constraint, subject, institution, value, form of power, or generative process can be relevant to several domains while carrying different analytical meanings in each. Economic dependence can have legal, political, educational, ecological, or epistemic conditions; legal recognition can alter economic capability; historical reconstruction can change the categories through which an economic process is described; educational and aesthetic processes can affect economic participation while retaining objects that are not exhausted by economic analysis. Cross-domain relevance therefore supplies a reason for interface construction. It does not by itself establish conceptual equivalence or a unified theory.

This distinction matters especially for a project that treats GRE as one domain instantiation of a broader Generative Relational orientation. The possibility of wider Generative Relational Theory (GRT) remains an open research question. It should emerge, if at all, through comparison among independently answerable domain programmes rather than through the premature elevation of economic vocabulary into general ontology. Chapter 23 accordingly treats domain boundaries as revisable but

consequential. A boundary may move when inquiry shows that an object, mechanism, or responsibility has been misclassified. Yet revision requires reasons that can be stated within both the originating and receiving domains.

The chapter has four principal objectives. First, it defines a discipline-interface grammar: disciplinary identity, principal problem-spaces, legitimate borrowing, translation, non-translation, and containment. Second, it develops explicit interfaces between GRE and neighboring domains, including Generative Relational History (GRH), Generative Relational Governance (GRG), Generative Relational Law (GR-Law), political theory, education, ecology, artificial-intelligence studies, social theory, and aesthetics. Third, it examines what GRE can export and what it must import, while preserving concepts whose meanings are non-equivalent across domains. Fourth, it uses boundary disputes, failed translations, cross-domain counterexamples, and candidate invariants to clarify the conditions under which later GRT-oriented generalization would be warranted.

The method is comparative and reflexive. Economic claims remain indexed to their evidential, historical, formal, and normative warrant when they cross a disciplinary boundary. The receiving domain is permitted to redescribe the object according to its own categories, to reject the proposed mapping, or to return a correction that changes the economic claim. Shared terminology therefore carries no presumption of shared extension. Conversely, domain-specific language does not make comparison impossible. Translation can be partial, task-relative, asymmetric, historically contingent, and still analytically useful when its preserved structures and losses are recorded.

Three restraints govern the chapter. The first is disciplinary containment: GRE should answer economic questions with economic warrant and should identify where its authority ends. The second is interface reciprocity: neighboring domains are sources of correction rather than repositories from which GRE simply borrows useful vocabulary. The third is generalization restraint: recurrent structures across domains are candidates for wider GR inquiry only after domain-specific evidence, counterexamples, and translation remainders have been examined. Similarity is an invitation to comparison rather than proof of invariance.

The internal sequence begins with disciplinary boundaries, containment, and translation. It then develops domain-specific interfaces, followed by an explicit account of GRE exports, imports, non-equivalent concepts, and boundary disputes. The chapter closes by asking which recurrent structures may deserve cross-domain comparison and which limits of GRE become visible precisely because those interfaces remain open. Section 23.1 establishes the initial architecture by treating disciplinary boundaries as relationally maintained interfaces whose permeability and revision require explicit warrant.

23.1 Relational Interfaces at Disciplinary Boundaries

A cross-domain research programme requires a precise account of what is crossing a boundary and why the boundary matters. The closing architecture of Chapter 22 permits GRE findings to generate questions for neighboring domains, but that permission does not determine where economics ends, which concepts can travel, or when another discipline's categories should replace an economic description. This section establishes the opening boundary grammar for Chapter 23. Its objective is to

Table 23.1: Principal operations at GRE disciplinary boundaries

Boundary operation	Primary analytical object	Disciplinary requirement
Disciplinary identity	Principal questions, objects, warrants, and responsibilities	State what makes an inquiry economic without treating present boundaries as timeless
Problem-space specification	Economic relations among resources, capabilities, value, institutions, power, and generative consequences	Preserve the local economic question before importing another domain's categories
Boundary maintenance	Conditions for retaining, moving, or differentiating a domain boundary	Keep boundary claims revisable through evidence and cross-domain correction
Interface construction	Transfer of questions, distinctions, evidence, or models across domains	Record preserved structure, translation loss, and domain-specific remainder
Shared-concept comparison	Similar vocabulary used in multiple domains	Compare meanings and inferential roles before assuming equivalence
Domain-specific concept protection	Concepts whose validity depends on a domain's own institutions, norms, or objects	Preserve the receiving domain's authority to reject reductive translation
Translation	Partial mapping with explicit task and scope	Evaluate adequacy relative to the research purpose rather than lexical resemblance
Non-translation	Material failure or inadmissibility of a proposed mapping	Preserve failure as information about domain structure and limits of generalization

characterize disciplinary identity through principal problem-spaces and standards of answerability, then specify interfaces that permit borrowing and mutual correction without collapsing distinct domains into a common vocabulary. The discussion proceeds through disciplinary identity, the principal GRE problem-space, boundary formation, interface discipline, shared and domain-specific concepts, translation, and non-translation. The method is comparative and reflexive: boundaries are treated as historically generated and revisable, while every proposed crossing remains accountable to the objects, questions, evidence, and responsibilities of the participating domains.

Definition 23.1 (Disciplinary interface record). A *disciplinary interface record* identifies an originating domain, a receiving domain, the question or object motivating contact, the originating claim and its warrant, the concepts proposed for transfer, the structures expected to be preserved, anticipated translation losses, domain-specific responsibilities that remain outside the transfer, and the conditions under which the interface should be revised or abandoned.

Definition 23.1 turns disciplinary contact into a traceable research operation. The record is intentionally directional. An economic concept may travel into legal inquiry under one mapping while a legal concept returns to economics under another. The two translations need not preserve the same structures. This asymmetry is analytically useful because disciplinary interfaces often connect different principal questions rather than duplicate formulations of one problem.

Proposition 23.2 (Boundary answerability condition). A *disciplinary boundary* is *analytically defensible when researchers can state which questions the domain claims responsibility for, what kinds of warrant it recognizes for those questions, where neighboring expertise becomes necessary, and what evidence would justify revising the present boundary*.

Table 23.1 summarizes the boundary operations developed in this section. The table is not a taxonomy of disciplines. It identifies the recurrent operations through which domain identity and cross-domain inquiry can remain jointly accountable.

23.1.1 Disciplinary Identity

Disciplinary identity is often described institutionally through departments, journals, professional associations, degree programmes, and recognized methods. Those structures matter because they distribute authority, training, resources, visibility, and standards of evidence. For the present inquiry, however, institutional location alone is insufficient. GRE requires an analytical account of disciplinary identity that can remain meaningful when institutions change or when one research problem crosses several established fields.

Definition 23.3 (Disciplinary identity profile). A *disciplinary identity profile* records a domain's principal problem-space, characteristic analytical objects, recognized forms of evidence and inference, normative or practical responsibilities, historical lineages, institutional locations, recurrent interfaces with neighboring domains, and acknowledged limits of competence.

The profile treats a discipline as a historically maintained configuration rather than a fixed essence. Economics has repeatedly changed the objects, methods, scales, and institutions through which it defines legitimate inquiry. Such changes can be substantial without making disciplinary identity arbitrary. Continuity can be carried by recurring problem-spaces, inherited debates, institutional practices, analytical objects, and relations to adjacent fields even when their relative importance changes.

For GRE, disciplinary identity is further complicated by its relation to broader Generative Relational inquiry. GRE uses relational, generative, historical, and multiscale concepts that may also appear in history, governance, law, education, ecology, or social theory. Their recurrence does not dissolve economics. Economic specificity is maintained through the questions for which those concepts are mobilized: how resources and capacities are allocated; how value forms are generated, converted, circulated, captured, returned, and regenerated; how economic institutions structure participation and dependency; how power conditions economically relevant possibilities; and how these processes alter future generative capacity.

Proposition 23.4 (Identity-through-problem-space condition). *GRE retains disciplinary identity when its relational and generative concepts remain organized around economically specific problem-spaces and evidential responsibilities, even if some concepts are shared with neighboring domains.*

This condition avoids two opposite errors. Shared concepts need not be monopolized by one discipline, while the recurrence of those concepts does not imply that every domain studies the same object. A legal right, political authority, educational relation, ecological constraint, and economic capability may all participate in one empirical configuration. Their disciplinary meanings remain differentiated by the questions being asked and the standards under which answers become warranted.

23.1.2 Principal Problem-Space

A boundary becomes clearer when the principal problem-space is stated positively. GRE's principal problem-space concerns the economic conditions and consequences through which resources, capabilities, relations, institutions, value forms, power structures, and historical configurations affect the generation, preservation, conversion, circulation, capture, return, and regeneration of economically relevant possibilities. The formulation is broad because the book has treated economic pro-

cesses as relationally embedded and temporally extended. Breadth nevertheless differs from disciplinary totalization.

Definition 23.5 (GRE principal problem-space). The *GRE principal problem-space* comprises questions about economically consequential allocation, production, value generation, conversion, circulation, return, capability formation, institutional organization, participation, dependence, power, and transformation, including their historical and relational conditions and their effects on later economic possibility.

The definition is intentionally functional rather than jurisdictional. It does not claim exclusive ownership of any listed object. Power is also political; institutions are legal and social; capability formation is educational and developmental; value can be aesthetic, ecological, moral, juridical, cultural, and epistemic. The economic problem-space begins where these objects enter the organization of economic possibility and remains incomplete where their domain-specific constitution becomes necessary for explanation or evaluation.

This produces a practical test for boundary work. When an inquiry asks how a legal status changes access to productive resources, GRE can study the economic incidence, conversion effects, dependencies, and later generative consequences. When the inquiry asks whether the status is legally valid, how rights and duties are constituted, or what doctrine authorizes recognition, legal analysis becomes indispensable. Similarly, GRE can investigate the economic conditions of education and the later economic effects of learning relations while leaving pedagogical validity, curricular judgment, or the nature of educational flourishing to educational inquiry unless those questions are explicitly reconstructed through an appropriate interface.

Proposition 23.6 (Problem-space anchoring condition). *A cross-domain GRE inquiry should identify the economic question that motivates the interface before importing concepts, methods, or conclusions from a neighboring domain. The imported material should be evaluated by the explanatory or evidential role it plays in that stated problem-space.*

Problem-space anchoring also guards against decorative interdisciplinarity. Borrowing a concept because it appears intellectually adjacent contributes little unless the concept changes the specification of an object, mechanism, evidence, comparison, normative remainder, or research decision. The same discipline applies to formal borrowing. A mathematical structure shared across fields creates an interface only when its preserved relations and analytical role can be stated.

23.1.3 Boundary Formation

Disciplinary boundaries are historically generated through recurring divisions of labor, institutional authority, methods, concepts, data infrastructures, professional training, and normative responsibility. Their historical formation does not make them dispensable. A boundary can protect distinctions that would otherwise be lost, including the difference between economic control and legal ownership, economic dependence and political subordination, educational capability and labor-market productivity, or ecological value and monetized environmental benefit.

Definition 23.7 (Relational disciplinary boundary). *A relational disciplinary boundary is a historically maintained distinction among domains that allocates principal questions, conceptual responsibilities, evidential standards, and interpretive authority while permitting specified forms of exchange and revision across the boundary.*

The definition treats boundaries as maintained relations rather than impermeable walls. Their strength can vary across problems. Some interfaces are routine: economic history, political economy, law and economics, ecological economics, and economics of education already institutionalize cross-domain exchange in different forms. Other interfaces may remain provisional because the relevant concepts or standards of evidence have not stabilized.

A relational boundary also has an incidence structure. Boundary maintenance can distribute authority unevenly. One discipline may define the shared object, supply the accepted measurement architecture, or control publication venues while another contributes context treated as supplementary. Such arrangements can be epistemically productive in some settings and reductive in others. The relevant question is whether the boundary allocation preserves materially necessary distinctions and allows correction to travel in both directions.

Proposition 23.8 (Boundary permeability condition). *A disciplinary boundary is productively permeable when cross-domain exchange can alter questions, concepts, evidence, or conclusions on both sides while each domain retains responsibility for claims whose validity depends on its own specialized objects or standards.*

Permeability therefore differs from boundary erasure. A field can remain open to correction precisely because it can identify which correction comes from outside its present competence. The capacity to defer a question is part of disciplinary maturity when the deferral is explicit and accompanied by a well-specified interface.

23.1.4 Interface Discipline

An interface connects domains while preserving enough separation for disagreement to remain visible. The central risk is collapse: the receiving domain is redescribed using the originating domain's categories until apparent compatibility becomes inevitable. GRE faces this risk whenever economic vocabulary such as allocation, value, resource, capability, incentive, productivity, or return is extended into domains whose constitutive objects differ.

Definition 23.9 (Disciplinary interface). *A disciplinary interface is a documented relation between domains through which questions, concepts, methods, evidence, models, or corrections can pass while the originating and receiving domains preserve independently assessable standards for the claims that remain within their competence.*

A useful interface specifies direction, purpose, preserved structure, loss, and return path. Direction matters because the same pair of domains can support different interfaces. GRE may export an economic dependency profile to political theory as evidence relevant to authority or domination, while political theory may return distinctions concerning legitimacy or recognition that reorganize the economic analysis. Purpose matters because a translation adequate for empirical coding may be inadequate for normative evaluation. Preserved structure and loss prevent lexical identity from substituting for conceptual analysis. The return path makes correction possible.

Proposition 23.10 (Interface non-collapse condition). *A cross-domain interface remains analytically valid only while the receiving domain can reject, revise, or partially accept the imported structure without being required to restate its own objects in the originating domain's vocabulary.*

This proposition gives practical content to reciprocity. If ecological inquiry can enter a GRE project only after ecological values are monetized, the interface has already privileged an economic representation. If legal inquiry can contribute only through variables derived from economic incentives, juridical status and normativity may disappear. If education is represented solely through future earnings, learning and educational participation become visible only through one downstream economic manifestation. Interface discipline requires the possibility that such reductions are rejected as inadequate to the target-domain question.

23.1.5 Shared Concepts

Shared concepts create both opportunity and danger. Terms such as relation, subject, institution, power, value, justice, constraint, generation, reproduction, participation, recognition, and history occur across several domains. Their recurrence can support comparison, but lexical recurrence supplies weak evidence of conceptual equivalence.

Definition 23.11 (Shared-concept comparison profile). *A shared-concept comparison profile* records, for each participating domain, a concept's object of application, identity conditions, inferential role, evidential access, normative load, temporal structure, scale, and relationships to neighboring concepts, together with any preserved correspondences and unresolved differences.

Consider power. GRE studies economically relevant power through typed asymmetries, dependencies, control over conversion and circulation, constrained alternatives, and changes in future possibility. Political theory can require distinctions among authority, domination, legitimacy, collective action, and public justification that are not entailed by the economic diagnosis. Law may operationalize power through rights, duties, jurisdiction, enforceability, and standing. Social theory may treat power through field positions, reproduction, symbolic structures, or identity formation. The concepts intersect without becoming interchangeable.

The same discipline applies to value. GRE's heterogeneous value architecture permits several value forms and conversion regimes, yet aesthetic, moral, ecological, juridical, and educational values may contain evaluative standards that economics cannot establish internally. A shared-concept comparison can reveal structural similarities, translation possibilities, and recurring tensions while preserving the domain in which a particular evaluative warrant must be defended.

Proposition 23.12 (Lexical non-equivalence condition). *Shared terminology across domains warrants conceptual comparison, not presumed equivalence. Equivalence claims require explicit correspondence among the concept's relevant objects, inferential roles, and boundary conditions for the task at hand.*

This condition also protects productive disagreement. A cross-domain project gains information when two fields use the same term differently and can state why. The mismatch may indicate different empirical objects, different levels of abstraction, different normative responsibilities, or a historical transformation that a shared vocabulary conceals.

23.1.6 Domain-Specific Concepts

Cross-domain work also depends on concepts whose domain specificity should be protected. Some concepts are constituted through legal rules, political institutions, educational practices, ecological processes, historical methods, aesthetic judgment, or social meanings in ways that resist immediate economic translation. Their resistance can identify the point at which an economic account becomes incomplete.

Definition 23.13 (Domain-specific conceptual remainder). A *domain-specific conceptual remainder* is a feature of a concept, object, or relation that is material to the receiving domain's inquiry and is not preserved adequately by the proposed cross-domain mapping.

Remainders can be normative, institutional, semantic, temporal, ontological, evidential, or practical. Legal personhood, for example, cannot be inferred from economic agency alone because juridical recognition has constitutive rules and consequences. Ecological regeneration cannot automatically be restated as economic return because ecological processes may have identity conditions and temporalities independent of human valuation. Aesthetic judgment can condition salience, orientation, and value formation without becoming reducible to preference revelation. Educational capability can affect economic possibility while remaining partly constituted through pedagogical relations and learning processes.

Proposition 23.14 (Remainder preservation condition). A *cross-domain analysis* should preserve domain-specific conceptual remainders whenever their removal would change the receiving domain's object, evidential standard, normative responsibility, or practical conclusion.

Remainder preservation does not prohibit abstraction. Comparative research often requires selecting a limited set of features. The discipline lies in stating what has been abstracted away and whether the omitted material can alter the inference. This creates a principled boundary between useful simplification and reduction that invalidates the target-domain question.

23.1.7 Translation

Translation is the principal constructive operation at a disciplinary interface. It connects concepts or structures sufficiently for a specified research task while allowing the mapping to remain partial, directional, and revisable. Chapter 21 used translation to compare economic theories; Chapter 22 extended the operation to research programmes and neighboring domains. Chapter 23 requires a more explicitly disciplinary account because the receiving domain may have different standards of evidence and different responsibilities for what follows from a translated claim.

Definition 23.15 (Cross-domain translation). A *cross-domain translation* is a task-indexed mapping from an originating domain's object, concept, relation, model, evidence, or question into a receiving domain that specifies the structure intended to be preserved, the inferential purpose of the mapping, the transformation performed, the losses introduced, and the conditions under which the mapping remains adequate.

Translation can occur at several levels. A conceptual translation may connect economic capability with an educational account of capability while preserving different constitutive mechanisms. A functional translation can compare institutions by the role they play without claiming identical internal structure. A structural translation

may preserve a pattern of dependency or feedback across different domain objects. A formal translation can reuse a mathematical representation under new interpretations. Historical translation may connect categories across periods while recording semantic and institutional change. Each mode preserves different information.

Proposition 23.16 (Task-relative translation adequacy). *A cross-domain translation is adequate only relative to a stated research task. A mapping sufficient for descriptive comparison does not thereby become sufficient for causal explanation, normative judgment, legal classification, institutional design, or ontological generalization.*

This task relativity prevents a successful local mapping from accumulating unearned scope. A common network representation may support comparison of relational position without showing that the relevant ties have the same social or legal meaning. A shared dynamical model may represent feedback while leaving domain-specific causal interpretation unresolved. A common concept of generative capacity may organize questions across economics and education while requiring different manifestations and validation strategies.

Translation also has governance. Researchers decide which concepts travel, which differences receive attention, which language becomes the default, and which failures are recorded. Those decisions affect the visibility of domain-specific knowledge. A mature interface therefore documents who performs the translation, what disciplinary competencies are represented, and how affected or knowledgeable participants can contest the mapping when appropriate.

23.1.8 Non-Translation

A disciplined interface must permit a mapping to fail. Non-translation occurs when the structures required for a research task cannot be preserved with sufficient warrant, when the receiving domain's constitutive distinctions would be erased, when evidential regimes cannot be aligned responsibly, or when the proposed transfer creates more confusion than explanatory gain. Such outcomes delimit the present programme and provide evidence for later cross-domain comparison.

Definition 23.17 (Cross-domain non-translation record). *A cross-domain non-translation record documents a proposed mapping, its intended purpose, the point at which preservation failed or became inadmissible, the domain-specific distinction responsible for the failure, alternative mappings considered, the present consequence for the originating and receiving claims, and conditions under which future re-entry may become warranted.*

Non-translation has several possible meanings. The concepts may be genuinely non-equivalent. The empirical manifestations available in one domain may have no defensible counterpart in the other. A normative category may resist translation into descriptive economic language. A historical category may be too period-specific for synchronic comparison. A formal correspondence may preserve topology while losing institutional meaning. A proposed interface may also fail provisionally because the required evidence or domain expertise is unavailable.

Proposition 23.18 (Non-translation informativeness). *A well-documented failure of cross-domain translation is a substantive research result when it identifies a material boundary condition, domain-specific remainder, evidential incompatibility, or limitation on a proposed generalization.*

The proposition gives non-translation a constructive role in future GRT-oriented inquiry. Candidate general structures become more credible when they survive comparison with domains capable of rejecting them. Conversely, recurrent failures can show that a concept previously treated as general is specific to economic institutions, particular histories, or one evidential regime. A general theory, if later developed, should therefore be shaped as much by preserved non-equivalences as by recurrent correspondences.

The section's boundary architecture can be summarized through a final interface profile.

Definition 23.19 (GRE disciplinary-boundary profile). A *GRE disciplinary-boundary profile* combines the GRE principal problem-space, the neighboring domain's independently stated problem-space, shared and domain-specific concepts, permitted translations, recorded non-translations, reciprocal correction paths, and explicit criteria for revising the present boundary.

Proposition 23.20 (Relational disciplinary containment). *GRE remains disciplinarily contained when cross-domain inquiry preserves identifiable economic questions and warrants, records domain-specific remainders, allows neighboring domains to correct the economic account, and treats boundary revision as an evidentially and conceptually accountable outcome rather than as automatic expansion of GRE.*

Relational disciplinary containment supplies the opening architecture for Chapter 23. It permits disciplinary boundaries to be porous, historically revisable, and mutually corrective while retaining the distinctions required for substantive disagreement. The next section develops the containment principle more explicitly by specifying legitimate borrowing, limits of borrowing, domain accountability, interface accountability, and the conditions under which a disciplinary boundary should be revised.

23.2 The Disciplinary Containment Principle

Section 23.1 established the boundary grammar through which GRE can remain economically identifiable while maintaining explicit interfaces with neighboring domains. The present section develops the governing principle of that architecture. Its objective is to specify how a domain can borrow concepts, methods, evidence, and questions without extending its authority beyond the warrants it can defend, while remaining sufficiently open to correction that disciplinary identity does not become disciplinary closure. The discussion proceeds through principal questions, legitimate borrowing, limits of borrowing, conceptual imperialism, disciplinary closure, domain accountability, interface accountability, and boundary revision. The method is reflexive and procedural: containment is treated neither as institutional isolation nor as a fixed map of academic jurisdictions, but as an answerability condition on the claims a domain makes and the responsibilities it accepts.

Definition 23.21 (Disciplinary containment principle). The *disciplinary containment principle* requires a domain to keep its principal questions, claim types, evidential warrants, normative responsibilities, and limits of competence identifiable when it imports material from or exports material to neighboring domains. Cross-domain borrowing may enlarge the resources available to inquiry, while authority over the resulting claim remains indexed to the domain-specific warrants required for that

Table 23.2: Principal operations of disciplinary containment in GRE

Containment operation	Primary question	Required discipline
Principal-question specification	What is the inquiry principally asking?	Identify the problem-space and the domain whose warrant is required for the answer
Legitimate borrowing	What external concept, method, or evidence is being used?	Preserve provenance, interpretation, validation conditions, and domain-specific remainder
Borrowing limits	Which inferences do not travel with the borrowed resource?	State semantic, evidential, normative, temporal, and institutional limits
Conceptual non-domination	Does one domain's vocabulary predetermine the receiving domain's object?	Permit the receiving domain to reject or redescribe the imported structure
Disciplinary openness	What can external inquiry reveal about local blind spots?	Maintain routes for correction, counterexample, and problem reclassification
Domain accountability	Which claims remain the responsibility of GRE?	Match economic claims to economic evidence and identify claims requiring external warrant
Interface accountability	Who owns each cross-domain inferential step?	Record direction, translation loss, disagreements, and return paths
Boundary revision	What evidence warrants moving or differentiating the boundary?	Version the change and preserve consequences for earlier claims

claim.

Definition 23.21 gives containment a positive function. It protects the relation between a question and the kinds of reasons that can answer it. An economic analysis can incorporate legal status, historical sequence, ecological constraint, educational practice, political authority, or aesthetic judgment when those elements materially condition an economic process. Their inclusion does not grant economics independent authority to determine juridical validity, reconstruct historical meaning, establish ecological ontology, evaluate pedagogy, justify political legitimacy, or settle aesthetic normativity. The relevant neighboring domain remains capable of correcting the imported description.

Proposition 23.22 (Containment-through-answerability condition). *Disciplinary containment is preserved when each substantive claim can be traced to the principal question it answers, the domain-specific warrant required for that answer, and the interfaces through which external concepts or evidence entered the analysis.*

Table 23.2 summarizes the principal operations through which containment can remain compatible with cross-domain inquiry.

23.2.1 Principal Questions

Containment begins with the question rather than with the institutional affiliation of the researcher. One empirical configuration can support several legitimate inquiries because different domains ask different questions about it. A platform labor arrangement, for example, can be investigated economically through allocation, capability, dependency, conversion, capture, and return; legally through employment status, contractual obligation, rights, remedies, and jurisdiction; politically through authority, collective voice, and public justification; historically through institutional lineage and category change; and educationally through skill formation and access to learning. The configuration is shared while the principal questions remain distinct.

Definition 23.23 (Principal-question record). *A principal-question record states the phenomenon under investigation, the principal question being asked, the domain whose concepts and warrants are expected to answer that question, secondary ques-*

tions generated for neighboring domains, and the conditions under which the principal classification should be reconsidered.

This record reduces a recurrent source of disciplinary confusion. Researchers can begin from an economic concern and discover that the decisive unresolved issue is juridical, political, historical, educational, ecological, or ethical. The appropriate response is not to force the unresolved issue back into economic vocabulary. The research architecture should instead record a question handoff while retaining the economic consequences that motivated the inquiry.

Definition 23.24 (Question-handoff threshold). A *question-handoff threshold* is reached when answering a material subquestion requires constitutive concepts, evidential standards, normative warrants, or professional competencies that GRE does not presently supply with adequate justification.

The threshold does not require discontinuing the economic inquiry. It specifies where a cross-domain interface becomes necessary. An analysis of housing affordability can remain economic while requiring legal inquiry into tenancy rights or political inquiry into legitimate authority over land-use decisions. The outputs of those inquiries can subsequently alter the economic model. Containment therefore organizes a division of epistemic responsibility within an integrated problem rather than dividing the world into isolated objects.

Proposition 23.25 (Principal-question priority). *When several domains can describe the same empirical configuration, disciplinary responsibility should be assigned by the principal question and its required warrant rather than by the mere presence of a domain-associated object or vocabulary.*

This proposition prevents a legal institution from becoming exclusively a legal object, a monetary relation from becoming exclusively an economic object, or a historical event from becoming exclusively a historical object. Disciplinary identity attaches to the inquiry being conducted and the warrant claimed for its answer. The same object can therefore support multiple domain-specific analyses without implying that the domains are interchangeable.

23.2.2 Legitimate Borrowing

Cross-domain borrowing is indispensable to a relational economic programme because economic processes are constituted partly through institutions, meanings, histories, ecologies, legal categories, political arrangements, educational capacities, technologies, and social relations. Borrowing becomes legitimate when the external resource is used under conditions that preserve the reasons for which it was warranted in its originating domain and expose the transformation involved in bringing it into GRE.

Definition 23.26 (Cross-domain borrowing record). A *cross-domain borrowing record* identifies the borrowed concept, method, evidence, distinction, model, or research practice; its originating domain; its original analytical role and warrant; the economic task for which it is being borrowed; any reinterpretation performed; the structures preserved; the structures omitted; and the validation required in the GRE setting.

Borrowing can take several forms. GRE may borrow a historical periodization to reconstruct the emergence of an economic institution, a legal category to identify rec-

ognized forms of ownership, an ecological measure to represent a material constraint, an educational distinction to study capability formation, or a political-theoretical concept to formulate a question about authority that economics alone cannot resolve. It can also borrow methods, such as archival reconstruction, ethnography, network analysis, comparative institutional interpretation, or formal representations. Each form of borrowing carries a different transfer burden.

Proposition 23.27 (Borrowed-warrant preservation condition). *A borrowed resource is methodologically admissible in GRE when its economic use preserves the features material to its original warrant or explicitly revalidates the transformed resource under the new task.*

The condition allows adaptation. A method developed elsewhere need not remain unchanged when used economically. Its transformation should, however, be visible. A legal classification used as an empirical variable retains a different status from an economic proxy inferred from behavior. An ecological indicator produced through a specific measurement regime should not silently become a general measure of economic value. A historical category developed for one period may require reconstruction before being compared with another.

Definition 23.28 (Borrowing depth). *Borrowing depth* describes how deeply an imported resource enters the receiving analysis: as contextual information, measurement input, explanatory mechanism, constitutive category, normative premise, or structural component of the model.

The deeper the borrowing, the stronger the requirement for domain competence and interface documentation. Contextual information may require accurate attribution and scope control. A constitutive legal category or normative premise can reorganize the entire economic analysis and therefore demands stronger engagement with the domain that supplies it. Borrowing depth provides a practical way to scale the burden of interdisciplinary justification.

23.2.3 Limits of Borrowing

Borrowed resources can retain usefulness while carrying limits on the inferences that travel with them. These limits arise when a concept depends on institutions absent in the receiving case, when a measure changes meaning across populations or periods, when a method assumes a form of evidence unavailable in GRE, or when a normative conclusion requires justificatory premises that an economic analysis cannot establish.

Definition 23.29 (Borrowing-limit profile). *A borrowing-limit profile* records the semantic, evidential, institutional, temporal, normative, and practical limits that constrain the use of an imported resource in GRE, together with the claims that remain permissible and those that require additional domain-specific warrant.

A borrowing-limit profile is especially important when an imported term becomes familiar. Familiarity can conceal changes in meaning. Capability, recognition, resilience, agency, legitimacy, care, sustainability, personhood, and participation can all appear in economic research while retaining domain-specific structures that are not captured by an economic operationalization. The purpose of the profile is not to prohibit use. It prevents a useful partial representation from acquiring the status of a complete account through repetition.

Proposition 23.30 (Inference non-transfer condition). *The successful transfer of a*

concept, measure, method, or formal representation does not by itself transfer the originating domain's full set of conclusions. Each downstream inference requires its own warrant in the receiving task.

This is particularly important for formal and quantitative borrowing. The same network statistic can describe structurally similar positions while the social meaning of the ties differs. A dynamical representation can preserve feedback structure while leaving causal interpretation open. A legal category can predict economic behavior without its normative validity becoming an economic conclusion. A historical analogy can organize comparison without establishing recurrence of the underlying mechanism.

Definition 23.31 (Borrowing saturation point). *A borrowing saturation point is reached when further importation from a neighboring domain changes the principal question, required warrant, or explanatory responsibility enough that the inquiry should be reclassified, jointly governed, or handed off rather than treated as an expanded GRE analysis.*

The saturation point guards against indefinite disciplinary expansion. An economic project can deepen until its decisive claims are legal, political, educational, ecological, or otherwise external to economics. At that stage, continued labeling as GRE can obscure where the intellectual responsibility actually lies. Joint work can remain strongly connected to GRE while assigning the relevant claims to the appropriate domain.

23.2.4 Avoiding Conceptual Imperialism

A cross-domain programme also requires protection against conceptual imperialism: the tendency for one domain's vocabulary to become the default language through which neighboring objects are permitted to appear. In an economic context, this can occur when legal status is redescribed only as incentive structure, education only as human-capital formation, ecology only as externality or resource stock, political authority only as strategic control, care only as labor input, or aesthetic judgment only as preference. Each translation can illuminate one relation while suppressing others that are constitutive to the receiving domain.

Definition 23.32 (Conceptual dominance test). *A conceptual dominance test asks whether the receiving domain can formulate its object, disagreement, and correction in its own terms; whether those terms can alter the imported analysis; and whether a failed mapping remains admissible as an outcome rather than being reformulated until compatibility is achieved.*

The test shifts attention from vocabulary sharing to authority over description. Cross-domain collaboration is structurally asymmetric when one domain supplies the default ontology, variables, success criteria, and interpretation while the other contributes only contextual detail. Such asymmetry can sometimes be warranted for a narrowly defined task, but it should be identified rather than treated as neutral interdisciplinarity.

Proposition 23.33 (Non-domination condition for disciplinary interfaces). *A disciplinary interface satisfies a minimal non-domination condition when each participating domain can preserve material distinctions, reject inadequate translations, and return corrections that can change the originating analysis.*

The proposition gives practical meaning to reciprocity. An ecology interface is stronger when ecological inquiry can reject monetization as insufficient for a particular claim. A law interface is stronger when juridical status can alter the economic identification of an actor, asset, or obligation. An education interface is stronger when pedagogical and developmental evidence can revise an economic capability model. Cross-domain inquiry becomes more informative when the possibility of such correction is designed into the interface.

Definition 23.34 (Default-vocabulary asymmetry). A *default-vocabulary asymmetry* exists when one domain's categories are treated as the unmarked description of the shared object while another domain's categories appear only as optional qualifications, annotations, or downstream consequences.

Default-vocabulary asymmetry is not inherently illegitimate. Every inquiry needs a working language. It becomes methodologically significant when the default determines which objects are observable, which questions count as primary, or which disagreements can be expressed. Recording the asymmetry makes it possible to test whether the research conclusion depends on that linguistic architecture.

23.2.5 Avoiding Disciplinary Closure

Containment can fail in the opposite direction when boundary protection becomes disciplinary closure. A field that refuses external correction can preserve terminological purity while losing contact with constitutive conditions of its own objects. GRE is especially exposed to this risk because economic relations are historically and institutionally embedded. Changes in law, governance, education, ecology, technology, culture, or social organization can alter what counts as an economic subject, resource, capability, institution, or feasible action.

Definition 23.35 (Disciplinary-closure signal). A *disciplinary-closure signal* is evidence that a domain systematically excludes external concepts or findings that materially affect its principal questions, lacks a procedure for question handoff, or protects a claim from revision by classifying adverse evidence as outside the discipline without independent justification.

Closure can be methodological as well as conceptual. A discipline can recognize the relevance of another domain while admitting only evidence that has already been converted into its preferred method. Historical evidence can be accepted only after quantification; qualitative evidence only after coding into predetermined categories; legal analysis only when reduced to observable incentives; normative argument only when translated into preferences. Such practices can be useful within a particular design, but they become closure signals when alternative forms of warrant are excluded by default despite their relevance to the principal question.

Proposition 23.36 (Openness-with-containment condition). A *contained discipline remains open when it maintains explicit procedures for receiving external correction, re-classifying questions, revising local concepts, and acknowledging constitutive conditions that it cannot establish internally*.

Openness therefore does not require unrestricted borrowing. The more disciplined form of openness is selective and answerable: the field can explain why an external contribution is relevant, what role it plays, how it is validated, and what changes if the neighboring domain rejects the proposed use. This form of openness protects the research programme from both conceptual expansion and self-insulation.

Definition 23.37 (External-correction path). An *external-correction path* specifies how a finding or objection from a neighboring domain can enter GRE, which claims it can modify, who evaluates the correction, what additional evidence may be required, and how the resulting change is recorded.

External-correction paths make interdisciplinary learning cumulative. Without them, cross-domain engagement can remain rhetorical: neighboring disciplines are cited or consulted while the economic architecture remains immune to revision. A versioned correction path creates an observable relation between interface activity and conceptual change.

23.2.6 Domain Accountability

Domain accountability concerns the claims for which GRE itself accepts responsibility. The broad scope of the book makes this requirement important. GRE can study the economic effects of legal recognition, political authority, educational inequality, ecological constraints, social norms, and AI-mediated capabilities. It should distinguish those economic claims from claims about the validity, legitimacy, pedagogical adequacy, ecological meaning, social identity, or ethical permissibility of the external structures involved.

Definition 23.38 (Domain-accountability ledger). A *domain-accountability ledger* records each material claim in a cross-domain inquiry, the principal domain responsible for warranting it, supporting evidence or argument, imported dependencies, unresolved external questions, and the consequences of later correction for the GRE analysis.

The ledger can expose mixed claims that otherwise appear seamless. Consider the proposition that a regulatory change increased generative opportunity. The legal fact that a rule changed, the economic evidence concerning capabilities or options, the historical interpretation of the change, and the normative evaluation of the resulting distribution may require different warrants. A single sentence can therefore contain several disciplinary responsibilities. Making them explicit improves both rigor and collaboration.

Proposition 23.39 (Claim-to-domain matching condition). A *cross-domain GRE claim* is adequately contained when the domain responsible for each material inferential step can be identified and the claim's strength does not exceed the strongest warrant available across those steps.

This condition introduces a weakest-link discipline without requiring every project to become fully interdisciplinary. A study can bracket a neighboring-domain question when the bracket is explicit and immaterial to the present conclusion. When the bracketed issue is constitutive to the conclusion, the required warrant becomes part of the research burden.

Definition 23.40 (Domain-responsibility remainder). A *domain-responsibility remainder* is a material component of a research claim whose justification lies outside GRE and remains unresolved, contested, or only provisionally imported within the present analysis.

Responsibility remainders should remain visible in conclusions. They do not automatically invalidate a result. They specify the condition under which the result may later need reinterpretation. This practice is especially valuable in policy-facing work,

where economic findings can otherwise acquire legal or normative implications that were never independently warranted.

23.2.7 Interface Accountability

Domain accountability concerns who warrants a claim. Interface accountability concerns the quality of the relation through which claims, concepts, evidence, and corrections move between domains. A well-defined interface should make the transfer inspectable by participants from both sides and should preserve the possibility of disagreement about the mapping itself.

Definition 23.41 (Interface-accountability record). An *interface-accountability record* identifies the participating domains, direction of transfer, task, borrowed or exported object, translation procedure, preserved structures, losses, domain-specific remainders, validation responsibilities, disagreements, decision authority, return path, and revision history of the interface.

The record adds governance to translation. Cross-domain work often fails through unrecorded decisions about terminology, variable construction, aggregation, authorship, evidential priority, or whose expertise settles a dispute. These are not merely interpersonal matters. They can affect the resulting object of knowledge. Interface accountability therefore includes the architecture through which disagreement is handled.

Proposition 23.42 (Two-sided contestability condition). *A cross-domain interface is strongly accountable when both originating and receiving domains can contest the mapping, require clarification of losses, and trigger revision of claims that depend on the interface.*

Two-sided contestability does not imply symmetrical expertise or equal authority over every issue. The relevant symmetry is procedural: each domain can challenge claims that depend on its own objects or warrants. In a legal-economic project, legal researchers need not determine an econometric specification merely because law is relevant, and economists need not determine the validity of a juridical classification merely because it has economic consequences. The interface allocates authority by claim type.

Definition 23.43 (Interface burden of proof). The *interface burden of proof* is the justificatory burden carried by the party proposing that a concept, method, evidence type, or formal structure travels across a disciplinary boundary with sufficient preservation for the stated task.

This burden matters because translation often benefits the originating framework by extending its reach. Requiring the receiving domain to prove non-equivalence can privilege the proposed mapping. A more balanced procedure asks the proposer to state what is preserved, why the mapping is useful, and what evidence would show that the transfer is inadequate. The receiving domain can then contest a documented claim rather than an implicit assumption.

23.2.8 Revisable Boundaries

Disciplinary containment remains compatible with historical change only if boundaries can be revised. New objects, methods, institutions, technologies, and cross-

domain findings can alter the distribution of questions and competencies. GRE itself is evidence that disciplinary programmes evolve: its relational, historical, formal, and normative interfaces differ from narrower conceptions of economic analysis. Revision therefore belongs inside the containment principle rather than appearing as an exception to it.

Definition 23.44 (Boundary-revision record). A *boundary-revision record* documents the previous disciplinary allocation, the anomaly or accumulated evidence motivating revision, the proposed new allocation, concepts and responsibilities affected, gains and losses produced by the change, consequences for earlier claims, dissenting interpretations, and conditions for later reassessment.

Boundary revision can take several forms. *Expansion* brings a question into GRE because economic inquiry has developed sufficient concepts and warrant to answer it responsibly. *Contraction* transfers a question outward after evidence shows that its decisive structure lies elsewhere. *Differentiation* divides a previously unified question into components with distinct disciplinary responsibilities. *Joint governance* treats a problem as persistently cross-domain because no single field can answer the principal question without constitutive contributions from another.

Proposition 23.45 (Boundary-revision warrant). A *disciplinary boundary should be revised when the proposed change improves answerability to the relevant questions, preserves material domain-specific distinctions, and produces a clearer allocation of evidential or normative responsibility than the existing boundary.*

This proposition keeps revision from becoming automatic expansion. The discovery that GRE can model a neighboring phenomenon does not itself make that phenomenon an economic object. Conversely, evidence that economic conditions constitute part of a legal, educational, ecological, political, or aesthetic process does not require GRE to withdraw from studying those conditions. Revision concerns the allocation of explanatory and justificatory responsibility rather than possession of the object.

Definition 23.46 (Containment revision cycle). A *containment revision cycle* consists of principal-question specification, domain allocation, cross-domain borrowing where necessary, interface testing, external correction, identification of unresolved responsibility remainders, and versioned revision of the boundary when warranted.

Proposition 23.47 (Revisable containment). *Disciplinary containment is sustainable when it constrains present claims while preserving procedures through which later evidence, concepts, and cross-domain disagreements can alter the boundary itself.*

The disciplinary containment principle therefore provides a middle architecture between conceptual expansion and disciplinary closure. GRE can remain economically identifiable because its principal questions and warrants are explicit; it can remain relationally open because borrowed concepts retain provenance, neighboring domains can reject inadequate mappings, and boundary revision has a documented path. The next section examines the translation problem at greater resolution by comparing relational, generative, ontological, epistemic, methodological, and normative compatibility across GR domains and by specifying the losses and domain-specific remainders that can persist even when translation is productive.

23.3 Translation across GR Domains

Sections 23.1 and 23.2 established a disciplinary boundary grammar and a containment principle for cross-domain inquiry. The present section examines the translation operation itself. Its objective is to specify when concepts, distinctions, models, evidence, and research practices can travel between GRE and neighboring Generative Relational domains without converting resemblance into identity or borrowing into disciplinary absorption. The discussion proceeds through shared relational and generative vocabularies, ontological, epistemic, methodological, and normative compatibility, translation loss, and domain-specific remainders. The method is comparative and task-relative: translation is evaluated against the specific research function it is meant to serve, and compatibility is treated as a property of a proposed interface under stated conditions rather than as a global property of two domains.

Definition 23.48 (Cross-domain translation specification). A *cross-domain translation specification* identifies an originating domain, a receiving domain, the source object or claim, the target research task, the concepts or structures proposed for transfer, the meanings and inferential roles expected to be preserved, the compatibility conditions required for the task, anticipated losses, domain-specific remainders, validation responsibilities, and stopping conditions for the translation.

Definition 23.48 treats translation as a research design object rather than a lexical operation. A term can have the same surface form in several GR domains while playing different explanatory, evidential, normative, or institutional roles. Conversely, different words can perform structurally comparable work. The adequacy of a translation therefore depends on what the translation is being asked to preserve.

Proposition 23.49 (Task-indexed translation condition). A *cross-domain translation* is adequately specified only relative to a stated task, because a mapping that preserves enough structure for descriptive comparison may remain inadequate for causal explanation, formal modeling, institutional design, legal classification, normative judgment, or ontological inference.

Table 23.3 summarizes the principal compatibility dimensions developed in this section. The dimensions are analytically separable. Compatibility on one dimension does not automatically establish compatibility on another.

23.3.1 Shared Relational Vocabulary

Generative Relational domains are likely to share terms such as *relation*, *position*, *constraint*, *subject*, *institution*, *field*, *dependence*, and *configuration*. Shared vocabulary can lower the cost of comparison, but it also creates a particular risk: the same word can conceal different units, directions of explanation, evidential requirements, and normative consequences. A legal relation, an economic relation, an educational relation, and a historical relation need not be interchangeable simply because each is relational.

Definition 23.50 (Relational-vocabulary alignment profile). A *relational-vocabulary alignment profile* records, for a term used in two or more domains, its local definition, analytical object, relata, directionality, temporal scope, scale, constitutive conditions, observable manifestations, inferential role, and domain-specific remainder.

The profile prevents a common form of false equivalence. Consider *institution*. In GRE, an institution may be analyzed through the economic relations it stabilizes, the

Table 23.3: Principal compatibility dimensions in translation across GR domains

Compatibility dimension	Primary translation question	Required restraint
Relational vocabulary	Do terms such as relation, position, dependence, field, or institution retain comparable analytical roles?	Compare semantic and inferential use rather than assuming identity from shared terminology
Generative vocabulary	Do generation, capacity, emergence, reproduction, return, or transformation refer to comparable processes and horizons?	Preserve process, temporal, and source–outcome structure
Ontological compatibility	Can the domains use compatible analytical objects without making contradictory ontological commitments?	Distinguish representational compatibility from ontological identity
Epistemic compatibility	Can evidence and warrants travel with the claim being translated?	Preserve provenance, observability, uncertainty, and domain-specific standards of support
Methodological compatibility	Can a method address the receiving domain’s object without silently changing it?	Revalidate units, boundaries, categories, and inference rules in the receiving domain
Normative compatibility	Can evaluative concepts cross domains without transferring normative authority by default?	Keep reasons, standing, affected subjects, and justificatory responsibility explicit
Translation loss	What semantic, inferential, temporal, institutional, or evidential structure is omitted or transformed?	Record loss before treating the mapping as adequate
Domain-specific remainder	Which material structures resist transfer for the stated task?	Preserve the remainder as part of the result rather than forcing completion

allocation and conversion rules it mediates, and the generative consequences it produces. In law, the relevant institutional object may depend on recognized authority, jurisdiction, competence, validity, procedural form, or legal standing. In political theory, institutional analysis may center legitimacy, authority, participation, or public justification. The same empirical organization can participate in each analysis while the relevant institutional relation differs.

Definition 23.51 (Relational translation unit). A *relational translation unit* is the smallest relational structure that must remain identifiable for a proposed cross-domain mapping to perform its stated task. It may include the relata, relation type, direction, temporal condition, scale, institutional embedding, or dependence structure required by the target inference.

The translation unit is task-dependent. If the purpose is to compare whether two domains recognize asymmetric dependence, the unit may be relatively simple. If the purpose is to transfer a claim about legally enforceable dependence into economic analysis, the translation unit may also require the legal source of obligation, enforceability, standing, remedies, and temporal validity. Translation becomes weaker when the receiving domain retains only a generic statement that one position depends on another.

Proposition 23.52 (Relational non-equivalence under shared vocabulary). *Shared relational terminology supports a presumption of comparability only at the level of the specified translation unit; it does not by itself establish equivalence of the relation’s constitution, evidence, causal role, or normative significance across domains.*

This proposition allows relational language to function as an interface without becoming a hidden general ontology. Cross-domain research can ask whether several domains distinguish dependence from interaction, position from attribute, or institution from isolated event. Yet the answer should be recorded at the level actually supported. A recurrent distinction can become a candidate cross-domain structure

while domain-specific conditions remain visible.

23.3.2 Shared Generative Vocabulary

A second family of shared terms concerns generation: *generative capacity*, *emergence*, *reproduction*, *transformation*, *return*, *maintenance*, *adaptation*, and *future possibility*. These terms can create an even stronger appearance of unity because they refer to change through time. The relevant processes, however, may differ substantially across domains. Economic generativity can concern later capability, value, relations, knowledge, or options; educational generativity can involve learning, judgment, curiosity, or participation; ecological generativity can involve regeneration of biophysical conditions; historical generativity can concern how earlier configurations condition later events and categories.

Definition 23.53 (Generative-vocabulary transfer record). A *generative-vocabulary transfer record* identifies the source process, generating configuration, generated object or capacity, temporal horizon, mediating conditions, maintenance requirements, possible failure modes, and the corresponding elements proposed in the receiving domain.

The record is intended to prevent a weak use of *generative* as a synonym for productive, beneficial, creative, or merely causal. A process is more strongly comparable across domains when the source of generation, the downstream object, and the temporal or relational pathway can be stated in each domain. Similar language without such a pathway may still be heuristically useful, but it supplies a weaker basis for translation.

Proposition 23.54 (Process-preservation condition). A *translation of generative vocabulary is stronger when it preserves the distinction among generating conditions, generative process, generated outcome, maintenance or reproduction, and the time horizon over which the claimed generation is evaluated*.

The condition matters because cross-domain translation can otherwise compress distinct processes into a single positive label. A legal institution can enable economic generativity without legal validity itself being reducible to economic generative performance. An educational arrangement can expand later economic capabilities while its educational value also depends on learning, autonomy, judgment, or participation that economics does not exhaust. Generative vocabulary can identify an interface while still preserving multiple domain-specific criteria of success.

Definition 23.55 (Generative correspondence level). A *generative correspondence level* records whether a cross-domain comparison concerns lexical resemblance, process analogy, functional correspondence, mechanism correspondence, or a stronger candidate structural invariance supported by domain-specific evidence.

This ordered distinction allows recurring structures to be studied without prematurely classifying them as invariants. A feedback loop observed in economic and ecological settings may support functional comparison. A stronger claim that the same formal mechanism is present would require a defensible mapping among states, transitions, constraints, observables, and failure conditions. Cross-domain generalization should therefore follow the evidence available at the relevant correspondence level.

23.3.3 Ontological Compatibility

Ontological compatibility is especially sensitive because the present book operates under ontological suspension. GRE uses relational, field, dynamical, spacetime, algebraic, and other representations where they clarify economic analysis, while refraining from treating those representations as direct descriptions of ultimate social ontology. Cross-domain translation should preserve that restraint.

Definition 23.56 (Ontological compatibility profile). An *ontological compatibility profile* records the analytical objects presupposed by each domain, the level at which those objects are treated as real, constructed, recognized, represented, or suspended, the dependencies among those commitments, and the strongest ontological claim required for the proposed translation.

Several kinds of compatibility are possible. Two domains may be *representationally compatible* when the same formal structure can be used without requiring agreement about what ultimately exists. They may be *object compatible* when each can identify sufficiently corresponding relational beings or configurations for a given task. They may remain *ontologically non-committal* when neither translation requires a stronger metaphysical claim. These forms should not be conflated with ontological identity.

Proposition 23.57 (Compatibility without ontological identity). *Cross-domain translation can be analytically adequate when the participating domains can coordinate their objects and representations for the stated task even though their deeper ontological interpretations remain different, suspended, or unresolved.*

This proposition is particularly important for candidate GRT development. Recurrent use of relations, fields, trajectories, or 2-complex-like representations across several domains can motivate comparison. It does not establish that the domains instantiate one common ultimate ontology. The generalization burden rises when a proposed cross-domain theory requires stronger ontological identification than the domain-specific research programmes themselves require.

Definition 23.58 (Ontological escalation threshold). An *ontological escalation threshold* is reached when a proposed translation can no longer perform its stated task through representational or object-level correspondence and instead requires a stronger claim that the participating domains instantiate the same underlying kind of being, relation, process, or structure.

Crossing this threshold is not prohibited. It changes the epistemic status of the inquiry. The resulting claim belongs to a stronger metaphysical or GRT-oriented programme and should receive independent argument rather than inheriting warrant from the success of a domain-specific model.

23.3.4 Epistemic Compatibility

Translation also depends on how a domain can know what it claims. GRE can use prices, accounts, institutional records, surveys, interviews, archives, observational data, experiments, formal models, and interpretive evidence. A neighboring domain can rely on partly overlapping materials while assigning them different epistemic roles. A legal text can be evidence of a recognized rule, an historical artifact, an economic constraint, a political settlement, and a social symbol, but the inferences licensed by the text differ across those uses.

Definition 23.59 (Epistemic interface profile). An *epistemic interface profile* identi-

fies the claim being translated, the source evidence and its provenance, the source-domain warrant, the receiving-domain manifestation or evidential bridge, uncertainty, missingness, contestation, and the additional validation required before the receiving domain can rely on the translated claim.

Epistemic compatibility is therefore stronger than shared access to data. A dataset created for administrative eligibility may be highly relevant to economic allocation while failing to capture informal access, hidden exclusion, or historical category changes. An ethnographic observation may reveal relational dependence that a legal classification does not recognize. An archived institutional record can illuminate formal rules while remaining silent about actual practice. Translation should preserve these asymmetries in observability.

Proposition 23.60 (Warrant non-substitution). *Evidence that warrants a claim in one domain does not automatically warrant the translated claim in another domain when the receiving inference depends on additional objects, manifestations, or standards of validation.*

This proposition prevents evidence from traveling more strongly than the claim. A legal determination that an actor possesses a right may be economically relevant, but it does not establish effective capability to exercise that right. An economic measure of control over a resource may identify practical influence while not establishing legal title. Historical evidence that a category emerged at a particular time can revise economic periodization without directly proving a causal economic mechanism.

Definition 23.61 (Epistemic revalidation requirement). *An epistemic revalidation requirement specifies which parts of a translated claim must be newly observed, reconstructed, interpreted, or tested because the receiving domain asks a different question or requires a different evidential bridge.*

Revalidation can be minimal when the receiving domain uses an externally established fact only as a boundary condition. It becomes more substantial when the external claim is constitutive to the receiving domain's explanation. The depth of epistemic revalidation should therefore track the role played by the translated material.

23.3.5 Methodological Compatibility

Methods often travel more easily than concepts because archival inquiry, ethnography, network analysis, surveys, experiments, comparative analysis, simulation, and formal modeling are already used across disciplines. Yet methodological portability can obscure a change in the object being measured or modeled. The same statistical or formal procedure can answer different questions depending on unit construction, boundary selection, variable meaning, temporal resolution, and inferential assumptions.

Definition 23.62 (Methodological transfer contract). *A methodological transfer contract records a method's original research object, assumptions, unit of analysis, boundary conditions, evidence requirements, inferential target, and known limitations, together with the corresponding elements in the receiving domain and the modifications required for adequate use.*

The contract distinguishes technique portability from methodological compatibility. Network analysis can be used in economics, political science, education, ecology, history, or social theory, but the meaning of a node, tie, boundary, missing relation,

and centrality measure may differ substantially. A dynamical model can represent economic variables and ecological states without implying that the modeled transitions have the same causal interpretation. A qualitative method can preserve situated meaning in one domain while requiring additional institutional or legal interpretation in another.

Proposition 23.63 (Method portability condition). *A method is portable across domains to the extent that its assumptions and inferential operations remain adequate after the receiving domain has re-specified the research object, units, boundaries, manifestations, and claim type.*

Methodological compatibility can therefore fail even when the computation runs correctly. The failure can arise because the receiving object is not adequately represented, because the unit of analysis changes meaning, because dependence violates the original design, or because the method's output cannot answer the domain-specific question. Recording such failures is part of cross-domain methodological learning.

Definition 23.64 (Methodological correspondence test). *A methodological correspondence test compares the source and receiving research designs across object definition, sampling or case selection, temporal and spatial boundaries, measurement, dependence structure, inferential target, validation, and revision conditions.*

The test is deliberately pluralistic. It does not rank formal, quantitative, historical, interpretive, qualitative, or computational methods on one scale. It asks whether the chosen method can answer the receiving domain's question with an identifiable warrant and whether another method is needed to recover structures lost in transfer.

23.3.6 Normative Compatibility

Normative translation requires additional restraint because evaluative concepts often carry domain-specific sources of authority. GRE can investigate distribution, participation, effective options, dependence, generative opportunity, conversion conditions, circulation, return, and economic consequences of institutional arrangements. Those findings can inform inquiry into justice, legitimacy, rights, educational goods, ecological stewardship, or aesthetic value. They do not by themselves settle the normative standards governing those domains.

Definition 23.65 (Normative interface profile). *A normative interface profile identifies the evaluative concept being translated, affected subjects or positions, the source of the relevant normative reasons, domain-specific standing and authority, empirical premises, comparison rule, unresolved value conflicts, and the claims that remain outside the competence of the originating domain.*

Normative compatibility can be partial. Economic evidence that one institutional design forecloses future options may be relevant to a political argument about participation, a legal argument about rights, an educational argument about agency, or an ecological argument about intergenerational stewardship. The relevance of the evidence does not imply that the normative concept has become economic. The receiving domain may assign different weight to the same consequence or regard another consideration as prior.

Proposition 23.66 (Normative authority non-transfer). *Cross-domain relevance of an economic consequence does not transfer normative authority to GRE when the justi-*

ficatory standard for the resulting judgment belongs partly or principally to another domain.

The proposition also runs in the reverse direction. A legal entitlement, political commitment, educational norm, or ecological value can constrain economic design without automatically determining every economic allocation question. Normative interfaces require explicit coordination among reasons rather than hierarchical absorption of one domain by another.

Definition 23.67 (Normative compatibility threshold). *A normative compatibility threshold is met for a specified cross-domain task when the participating domains can identify the relevant subjects, stakes, reasons, and comparison rules sufficiently to use one another's findings without attributing justificatory authority beyond what each domain can defend.*

This threshold permits collaboration even when normative theories remain contested. A study can compare how alternative legal rules distribute economic dependence while leaving the ultimate legal or political justification open. A policy analysis can identify economic consequences of ecological thresholds while recognizing that the selection of protected ecological goods may require independent normative and scientific inquiry.

23.3.7 Translation Loss

Cross-domain translation is rarely lossless. The relevant question is therefore not whether loss exists, but whether the loss is identifiable and acceptable for the stated task. Some losses are semantic: a term becomes broader or narrower. Others are inferential: the receiving domain can no longer draw conclusions available in the source domain. Temporal, scale, institutional, evidential, normative, and formal losses can also occur.

Definition 23.68 (Translation-loss ledger). *A translation-loss ledger records the structures omitted, transformed, aggregated, reclassified, or rendered unobservable during cross-domain translation, together with the reason for each loss, its expected effect on inference, whether it is reversible, and the tasks for which the translated object remains adequate.*

The ledger makes translation loss inspectable rather than treating it as an unavoidable but unspecified cost. A legal category translated into an economic indicator may lose procedural history and doctrinal distinctions. A historical narrative translated into model states may lose ambiguity and contested meaning. An economic capability profile translated into a governance analysis may fail to capture legitimate authority or public justification. A formal representation transported into another domain may preserve topology while losing institutional semantics.

Proposition 23.69 (Loss-sensitive adequacy). *A cross-domain translation remains adequate for a task when the recorded losses do not remove structures required for the target inference and when the receiving analysis does not silently rely on information the translation no longer contains.*

Loss-sensitive adequacy differs from completeness. A deliberately coarse translation can be useful when the research question is correspondingly coarse. Problems arise when later stages of analysis forget the original limitation and begin treating the translated object as if it retained the source domain's full meaning.

Definition 23.70 (Cumulative translation-loss threshold). A *cumulative translation-loss threshold* is reached when successive mappings, aggregations, reinterpretations, or formalizations remove enough task-relevant structure that the resulting object can no longer support the claim for which it is being used.

Cumulative loss is especially relevant in interdisciplinary pipelines. A historical category can first be operationalized as a variable, then aggregated across regions, then incorporated into a formal model, then exported into a policy comparison. Each step can be defensible individually while the sequence as a whole may no longer preserve the historical distinctions needed for the final claim. Translation provenance should therefore remain end-to-end rather than being documented only at the most recent interface.

Proposition 23.71 (Translation provenance continuity). *When a cross-domain claim depends on a sequence of translations, the final warrant should remain traceable through the intermediate mappings and losses that connect the originating evidence to the receiving inference.*

This proposition links translation discipline to the research-infrastructure architecture of Chapter 22. Versioned concepts, data provenance, model lineages, and disagreement records are not merely archival conveniences; they make cumulative cross-domain inference auditable.

23.3.8 Domain-Specific Remainders

Some structures remain material to a domain even after a useful translation has been achieved. These domain-specific remainders should not be treated as defects to be eliminated by further abstraction. They can identify precisely what a receiving domain cannot inherit without changing the question, the object, or the standard of warrant.

Definition 23.72 (Domain-specific remainder). A *domain-specific remainder* is a concept, distinction, evidential requirement, normative responsibility, historical condition, institutional form, or inferential dependency that remains material in its originating or receiving domain but is not adequately preserved by the proposed cross-domain translation.

Remainders can be small or constitutive. A historical dating convention may remain locally necessary without affecting an economic comparison. By contrast, legal validity, political legitimacy, educational meaning, ecological regeneration, or aesthetic judgment can be constitutive to the neighboring domain's principal question. Translating away such a remainder can change the object rather than merely simplify it.

Definition 23.73 (Remainder-protection rule). The *remainder-protection rule* requires a cross-domain analysis to preserve an explicit record of any remainder whose removal would materially change the source or receiving domain's principal question, warrant, or object of evaluation.

This rule has two consequences. First, cross-domain work can remain integrated without becoming reductive. A project can combine economic, legal, historical, ecological, and political components while leaving some judgments distributed across domains. Second, persistent remainders provide evidence about the limits of wider generalization. A candidate GRT concept should not be called invariant merely be-

cause domain-specific remainders have been omitted from the comparison.

Proposition 23.74 (Remainder-preserving translation). *A translation can be productive without being complete when it preserves enough shared structure for the stated task and leaves material domain-specific remainders visible, attributable, and capable of constraining the resulting inference.*

Definition 23.75 (Cross-domain translation portfolio). *A cross-domain translation portfolio is a versioned set of translation specifications, compatibility profiles, methodological transfer contracts, normative interface profiles, loss ledgers, failed mappings, and domain-specific remainders maintained across a family of GRE interfaces.*

The portfolio allows cross-domain comparison to accumulate without forcing convergence. Repeatedly successful mappings can become candidates for stronger comparison. Recurrent losses can indicate stable boundary structures. Failed mappings can identify concepts whose apparent similarity was superficial. Reinterpretation in a neighboring domain can also return corrections that change the economic object, its periodization, its measurement, or its normative significance.

Proposition 23.76 (Translation-with-remainder condition). *Cross-domain translation contributes to a wider Generative Relational research programme when it specifies the task, preserves the structures needed for that task, records compatibility and loss across relevant dimensions, protects material domain-specific remainders, and remains open to correction from the receiving domain.*

Translation across GR domains can therefore be systematic without presupposing general-theoretical identity. Shared relational and generative vocabularies create comparison opportunities; ontological, epistemic, methodological, and normative compatibility determine which forms of transfer are defensible; translation-loss records identify what has been transformed; and domain-specific remainders preserve the independent answerability of neighboring programmes. The next section applies this architecture to the first substantive interface, Generative Relational History, where historical generation, path dependence, multiple timescales, contingency, and retrospective re-epistemization directly condition economic analysis while retaining specifically historical responsibilities.

23.4 GRE–GRH Historical Interface

Sections 23.1–23.3 established the boundary, containment, and translation disciplines required before a substantive cross-domain interface can be developed. The present section applies those disciplines to the interface between Generative Relational Economics (GRE) and Generative Relational History (GRH). Its role is to specify how historical reconstruction can condition economic explanation without reducing history to a stock of background variables or allowing economic categories to organize the historical record by default. The objective is to identify the historical structures that GRE may legitimately import, the economic questions that can be sharpened through GRH, the corrections that historical inquiry can return to GRE, and the limits beyond which historical explanation should retain independent disciplinary responsibility. The discussion proceeds through historical generation, inherited constraint, path dependence, multiple timescales, fast–slow dynamics, contingency, retrospective re-epistemization, and limits of historical import. The method is interface-oriented and

Table 23.4: Principal operations at the GRE–GRH historical interface

Interface domain	GRE question	Historical responsibility and restraint
Historical generation	How did an economic structure become available, stabilized, or transformed?	Reconstruct formation without assuming current categories existed unchanged in the earlier period
Historical constraint	Which inherited structures condition present economic possibilities?	Identify provenance and transmission rather than treating inheritance as an unexplained residual
Path dependence	How does realized sequence alter later accessibility or transition structure?	Distinguish mechanism-supported dependence from persistence or retrospective storytelling
Multiple timescales	Which processes operate at materially different temporal resolutions?	Reconstruct scale-specific histories before assuming that one chronology represents all processes
Fast–slow dynamics	When is rate separation historically defensible?	Treat characteristic rates and scale separation as regime-dependent rather than permanent properties
Historical contingency	Which alternatives were practically accessible at a historical point?	Preserve uncertainty, branch structure, and contemporaneous constraints against retrospective inevitability
Re-epistemization	How should later evidence or categories revise an earlier economic reconstruction?	Separate change in warranted knowledge from change attributed to the underlying past process
Limits of historical import	Which historical findings can GRE legitimately incorporate?	Preserve historical meaning, evidential provenance, and non-economic remainders; stop import when translation changes the historical object

bidirectional: economic claims are made historically answerable, while historical claims are not required to become economic claims in order to matter.

Definition 23.77 (GRE–GRH interface record). *A GRE–GRH interface record identifies an economic object or claim, the historical formation relevant to it, the historical evidence and categories required for reconstruction, the economic mechanism or consequence under examination, the translation connecting the two domains, the domain-specific remainders retained on each side, and the corrections that either domain could return to the other.*

Definition 23.77 makes the interface narrower than a general statement that economics is historical. GRE can study value conversion, institutions, power, generative capacity, or allocation over time while still failing to reconstruct how the relevant categories, organizations, evidential records, and feasible alternatives came into being. Conversely, GRH can reconstruct the formation of an institution or economic category without reducing that history to a present economic mechanism. The interface becomes analytically useful when both contributions remain identifiable.

Proposition 23.78 (Historical answerability of economic claims). *A GRE claim whose explanatory force depends materially on inherited institutions, sequence, changing categories, temporal coupling, or historically differentiated possibilities should remain answerable to historical reconstruction concerning those dependencies rather than treating them as fixed initial conditions without provenance.*

Table 23.4 summarizes the principal interface operations developed below.

23.4.1 Historical Generation of Economic Structures

Economic structures are often encountered in GRE after they have already become recognizable as markets, firms, public agencies, property regimes, standards, infrastructures, professional roles, monetary arrangements, platforms, or systems of allocation. Historical inquiry asks a prior question: how did the structure acquire the relations, categories, authority, material support, and recognizability that allow it to function as the economic object now being analyzed? The answer cannot always be

supplied by extending the economic model backward in time. The historical object may have changed category, boundary, or meaning during its formation.

Definition 23.79 (Historical-generation profile). A *historical-generation profile* reconstructs the emergence or transformation of an economically relevant structure through its antecedent relations, formative events, actors and positions, institutional supports, material conditions, category changes, contested alternatives, stabilization mechanisms, and the evidential traces through which that history can presently be warranted.

The profile distinguishes formation from mere dating. Saying that a regulation was enacted in a particular year does not yet explain when the practical institution it enabled became operative, which earlier practices it codified, which actors resisted or reinterpreted it, or which complementary infrastructures made it economically consequential. Likewise, a technology can exist technically before standards, skills, finance, procurement, legitimacy, and network adoption generate a stable economic field around it.

Proposition 23.80 (Formation-sensitive economic interpretation). *When the present economic function of a structure depends materially on the process through which its relations, categories, or institutional supports were generated, an adequate GRE interpretation should preserve that formation history rather than representing the structure only through its current state.*

Historical generation can also correct economic periodization. A present-oriented economic analysis may date a transformation from a visible market event, legislative change, crisis, or technological release. GRH may identify a longer formation process whose decisive relational changes began earlier, or may show that a nominally singular transition consisted of several distinct historical phases. Such corrections can change the causal window of GRE analysis, the appropriate baseline, and the actors to whom economic effects are attributed.

23.4.2 Historical Constraint

Historical formation leaves constraints. Some are material, such as infrastructure, land use, accumulated debt, ecological depletion, or technical standards. Others are relational and institutional: established authority, ownership patterns, organizational routines, professional jurisdictions, classification systems, or inherited expectations. Historical constraint is therefore more specific than the observation that the present has antecedents. The question is how an inherited configuration continues to alter what later positions can do, access, contest, or generate.

Definition 23.81 (Historically inherited constraint). A *historically inherited constraint* is a restriction or conditioning structure whose present economic relevance depends materially on a prior historical formation and on one or more mechanisms through which that formation remains operative, is reproduced, or is transformed in the later configuration.

Definition 23.82 (Constraint-transmission record). A *constraint-transmission record* identifies the originating historical configuration, the mechanism by which its effects are carried forward, the later positions or relations affected, the transformations that occurred during transmission, and evidence capable of distinguishing inherited constraint from independently regenerated contemporary constraint.

This last distinction matters. Present inequality can resemble an earlier inequality without being produced through the same historical pathway. Conversely, an inherited structure can remain influential even after its original legal or organizational form disappears. The economic task is therefore not to attach a historical label to every current asymmetry, but to identify whether a historically formed constraint is part of the present mechanism.

Proposition 23.83 (Historical-constraint attribution). *A present economic limitation should be attributed to historical constraint only to the extent that an evidentially supported pathway connects the earlier formation to the later restriction, dependence, cost, capability difference, or altered option structure.*

Historical analysis can return a further correction: what GRE describes as a constraint may also have been a historically generated enabling condition for another position or activity. Rail routes can constrain later spatial development while having generated earlier connectivity; professional standards can restrict entry while preserving competence; fiscal institutions can limit discretionary action while enabling credible long-horizon coordination. GRH can reconstruct these layered functions without requiring GRE to assign one transhistorical valence to the inherited structure.

23.4.3 Path Dependence

GRE already treats path dependence as a mechanism-sensitive relation between realized history and later transition possibilities. The historical interface adds a disciplinary requirement: the relevant path must be reconstructed rather than inferred from persistence alone. GRH can investigate whether the alleged branch points, reinforcement mechanisms, switching costs, institutional sequences, and unrealized alternatives were historically available in the form assumed by the economic analysis.

Definition 23.84 (Path-dependence interface profile). *A path-dependence interface profile links a GRE claim about sequence-dependent economic accessibility to a GRH reconstruction of the relevant starting boundary, historical alternatives, realized events, reinforcement or hysteresis mechanisms, category changes, and evidence concerning later structural consequences.*

The interface guards against two symmetrical errors. Economic modeling can compress a long and contested history into a few state variables whose historical meaning is unclear. Historical narration can, in turn, identify a compelling sequence without establishing that the sequence altered later economic accessibility through the mechanism claimed. Path dependence becomes a strong cross-domain claim only when historical reconstruction and economic mechanism analysis support one another without being collapsed.

Proposition 23.85 (Historically warranted path dependence). *A cross-domain path-dependence claim is strengthened when the historical record supports both the practical accessibility of materially different earlier continuations and a transmission mechanism through which the realized sequence changed later economic possibilities.*

This proposition also protects contingency. Once a path is realized, later institutions can make it appear inevitable. A historically reconstructed branch can show that another continuation was once practically possible, while GRE can examine why the realized branch became progressively easier to reproduce or harder to leave. The two domains therefore divide labor: GRH reconstructs the historically situated alternative set and sequence; GRE can analyze the economic reinforcement, conversion,

allocation, and capability consequences associated with the path.

23.4.4 Multiple Timescales

Economic processes do not share one historical clock. Prices, transactions, organizational routines, educational capability, infrastructure, legal regimes, demographic change, ecological regeneration, scientific knowledge, and social trust can operate across markedly different horizons. GRE can represent these heterogeneous timescales and their couplings, but GRH can test whether the proposed temporal boundaries correspond to historically distinguishable processes rather than to convenient analytical aggregation.

Definition 23.86 (Timescale-correspondence profile). A *timescale-correspondence profile* records, for each temporally differentiated process in a GRE analysis, the historical events and intervals through which the process is reconstructed, its characteristic persistence or adjustment horizon, the evidence supporting that horizon, changes in its temporal organization, and the mechanisms coupling it to processes represented at other timescales.

A timescale can be institutionally produced. Annual budgeting, election cycles, reporting periods, debt maturities, school calendars, regulatory procedures, maintenance schedules, and archival practices create temporal structures that are neither purely natural nor arbitrary. Their historical origins can matter to economic explanation. If a fiscal institution changes its reporting cycle, for example, an apparent acceleration in policy response can partly reflect a changed institutional clock rather than a simple increase in economic responsiveness.

Proposition 23.87 (Historically grounded multitemporality). A *multiple-timescale GRE representation is historically stronger when the represented temporal resolutions correspond to reconstructible processes whose durations, boundaries, and couplings are supported by period-specific evidence rather than inferred solely from present observation frequency.*

This also affects aggregation. A century-long institutional transformation can contain several shorter regimes with different economic mechanisms. A monthly time series can conceal a slower category change that alters what the variable means. GRH can therefore reveal that measurements apparently occupying one continuous series belong to historically differentiated regimes. GRE should then decide whether to bridge, segment, or reinterpret the series rather than forcing temporal continuity.

23.4.5 Fast–Slow Dynamics

Fast–slow analysis is a stronger claim than the recognition of multiple timescales. It proposes that some processes change sufficiently faster than others that a rate separation clarifies their interaction. The historical interface asks whether that separation was stable over the period being studied, how the characteristic rates were institutionally or materially generated, and whether historical transitions altered which process counted as fast or slow.

Definition 23.88 (Historical fast–slow interface). A *historical fast–slow interface* links a GRE decomposition of relatively fast and slow processes to historical evidence concerning the origin, persistence, transformation, and breakdown of their characteristic rates and coupling mechanisms within a bounded regime.

Definition 23.89 (Rate-regime historicity). *Rate-regime historicity* is the condition that the characteristic pace of an economic, institutional, technological, ecological, or epistemic process can itself be historically generated and can change enough to alter a previously adequate fast-slow classification.

Market communication can accelerate after new infrastructure; legal change can become rapid during constitutional crisis; organizational routines can freeze under emergency; technological standards can stabilize after periods of rapid competition; ecological degradation can cross thresholds and accelerate. These are not exceptions to an otherwise timeless rate ordering. They show why the rate ordering itself belongs to the historical object.

Proposition 23.90 (Historically bounded rate separation). *A fast-slow decomposition imported into historical analysis should be treated as regime-bounded unless evidence supports persistence of the relevant rate separation across the wider period to which the claim is extended.*

This restraint matters for later governance interfaces as well. A governance arrangement designed around a historically stable mismatch can become inappropriate when one process accelerates, another slows, or cross-frequency coupling changes. GRH can identify when the temporal architecture changed; GRE can analyze the economic consequences of acting through institutions whose response horizons were formed under an earlier rate regime.

23.4.6 Historical Contingency

Historical contingency is often invoked loosely to mean that events could have been otherwise. At the GRE-GRH interface, a stronger account asks what alternatives were practically accessible to historically situated actors, which conditions made them accessible, what uncertainty existed at the time, and how later developments transformed the significance of the realized choice or event. Contingency is therefore related to, but distinct from, randomness and ignorance.

Definition 23.91 (Historical-contingency record). *A historical-contingency record* identifies a bounded historical configuration, the materially distinct continuations that were plausibly accessible within it, the actors and constraints relevant to those continuations, contemporaneous uncertainty or disagreement, the realized continuation, and the later mechanisms through which its consequences were amplified, attenuated, or transformed.

The requirement of practical accessibility prevents counterfactual imagination from becoming unlimited. An alternative need not have been equally likely, politically dominant, or economically optimal, but there should be historical grounds for treating it as more than a possibility invented from the later standpoint. Such grounds can include proposals, debates, competing standards, organizational capacities, unrealized investments, legal alternatives, or choices actually made in comparable settings.

Proposition 23.92 (Contingency-amplification condition). *A contingent historical difference becomes economically consequential for GRE when subsequent relations, institutions, investments, expectations, or constraints transmit or amplify that difference into later value, capability, allocation, dependence, or option structures.*

Historical contingency also disciplines responsibility claims. Later observers can

know consequences unavailable to earlier actors. GRH can reconstruct what alternatives and information were accessible at the time; GRE can analyze how the realized decision redistributed later economic possibilities. Keeping the two questions separate avoids both retrospective absolution and retrospective omniscience.

23.4.7 Retrospective Re-Epistemization

Later inquiry can change what is responsibly knowable about an earlier economic process. New archives can open, records can be digitized and linked, categories can be revised, previously excluded testimony can become available, and later consequences can make earlier patterns recognizable. GRE has already developed historical re-epistemization as a way to preserve this distinction. The GRH interface strengthens it by requiring later revision to remain historically situated rather than treating the newest reconstruction as if it had always been available.

Definition 23.93 (Cross-domain re-epistemization record). A *cross-domain re-epistemization record* preserves an earlier economic reconstruction, the evidence, categories, and methods available when it was formed, the later historical materials or conceptual changes that motivate revision, the revised reconstruction, and the specific descriptive, causal, evaluative, or classificatory claims whose warrant has changed.

This record can reveal several kinds of revision. A later archive may change the estimated timing of an institutional shift. A new category can make previously invisible labor recognizable. A changed model can show that observations formerly treated as independent belonged to one relational process. A long-delayed consequence can alter judgment about the generative effect of an earlier intervention. Each revision changes the epistemic relation to the past; none requires the claim that the past process itself changed because later inquiry changed.

Proposition 23.94 (Then–now epistemic separation). A *retrospective GRE–GRH revision* should distinguish what later inquiry can warrant about an earlier process from what relevant actors or analysts could reasonably know, classify, or infer within the earlier historical configuration.

This distinction is especially important for evaluation and attribution. Later evidence can support a stronger causal account while still showing that contemporaneous decision-makers lacked access to the evidence needed to form that account. Conversely, evidence of contemporaneous warnings can weaken claims that later-discovered harms were wholly unforeseeable. Re-epistemization therefore permits more accurate retrospective judgment without erasing historical epistemic position.

23.4.8 Limits of Historical Import

The GRE–GRH interface becomes reductive if every historically reconstructed distinction is converted into an economic variable, mechanism, or explanatory input. Historical meaning, chronology, periodization, archival absence, category formation, lived interpretation, and contested memory can remain material even when their economic consequence is uncertain. Historical import therefore requires an explicit stopping rule.

Definition 23.95 (Historical-import contract). A *historical-import contract* specifies the historical object or finding proposed for use in GRE, the economic task it is

intended to serve, the historical meaning and provenance that must remain preserved, the transformation required for economic use, the historical remainder not imported, the validation responsibility of GRE, and the conditions under which the import should be withdrawn or returned for further historical inquiry.

The contract prevents a common asymmetry in interdisciplinary work. Historical scholarship can be used merely to provide examples, dates, or background while economic theory determines in advance which features count as causally relevant. A more balanced interface allows historical reconstruction to alter the economic object itself. It can show that a category was unstable, that the assumed institution did not yet exist in its later form, that a period boundary is misplaced, or that two observations grouped together economically belonged to historically different relations.

Definition 23.96 (Historical-import saturation threshold). *A historical-import saturation threshold is reached when additional historical material becomes constitutive enough to the principal question, evidence, categories, or explanatory responsibility that the inquiry can no longer be adequately governed as GRE with historical support alone and instead requires joint GRE–GRH governance or reclassification.*

This threshold mirrors the borrowing discipline developed in Section 23.2. A GRE paper can legitimately use historical reconstruction without becoming a history paper. Yet when the principal controversy concerns archival interpretation, periodization, historical meaning, or reconstruction of the event sequence itself, historical expertise is no longer auxiliary. Domain accountability requires the research architecture to change accordingly.

Definition 23.97 (GRH correction return). *A GRH correction return is a historically warranted finding transmitted back to GRE that requires revision of an economic category, periodization, initial condition, mechanism, timescale, counterfactual set, evidential interpretation, or domain boundary.*

Correction returns are central to a genuinely bidirectional interface. A historical study can force GRE to split a supposedly stable category, move the beginning of a trajectory, revise the mechanism connecting two events, or recognize that a formal timescale decomposition was an artifact of later aggregation. Such revisions do not weaken interdisciplinary inquiry; they are evidence that the interface preserves independent answerability.

Proposition 23.98 (Historical-interface containment). *GRE can legitimately import historical findings when their provenance, historical meaning, and task-relevant distinctions remain preserved, the economic use is separately warranted, and material historical remainders remain visible; where historical reconstruction becomes constitutive to the principal question or where translation changes the historical object, the inquiry should shift toward joint governance or remain within GRH rather than expanding GRE by default.*

Definition 23.99 (GRE–GRH interface portfolio). *A GRE–GRH interface portfolio is a versioned collection of historical-generation profiles, constraint-transmission records, path-dependence interface profiles, timescale-correspondence profiles, fast-slow interface records, contingency records, re-epistemization records, historical-import contracts, non-import decisions, and GRH correction returns maintained across related research programmes.*

Proposition 23.100 (Historical-interface answerability). *A mature GRE–GRH interface should make it possible to state which economic claims depend on historical forma-*

tion, which historical reconstructions support or weaken those claims, which translations were performed, which historical structures were deliberately not imported, which corrections returned to GRE, and which unresolved questions remain properly historical rather than economic.

The historical interface therefore adds more than context to GRE. Historical generation identifies how economic objects become possible; inherited constraint and path dependence connect realized sequence to later accessibility; multiple timescales and fast-slow analysis become historically bounded rather than timeless classifications; contingency preserves unrealized alternatives against retrospective inevitability; and re-epistemization permits later correction without overwriting earlier epistemic positions. The next section examines multiscale historical time and transition.

23.5 Multiscale Historical Interfaces

Section 23.4 established the general GRE–GRH historical interface. The present section deepens that interface by examining historical processes that become intelligible only when several temporal resolutions are distinguished and related. Its role is to specify how event time, institutional time, structural time, and intergenerational time can be represented without converting them into fixed ontological layers. The objective is to identify economically relevant cross-scale couplings, diagnose circumstances in which apparent scale separation fails, reconstruct transitions whose timing differs across processes, and formulate provisional multiscale hypotheses with explicit ontological restraint. The discussion proceeds through four temporal resolutions, their couplings, breakdown of separation, historical transition, economic interpretation, and formal hypotheses. The method is historical and relational, with formalization used only where it clarifies lag, memory, coupling, or regime change.

Definition 23.101 (Multiscale historical interface record). *A multiscale historical interface record specifies a historical-economic object, the temporal resolutions relevant to it, the processes assigned provisionally to each resolution, their characteristic response or persistence horizons, the mechanisms connecting resolutions, the evidence supporting those assignments, the historical regimes within which they remain useful, and the revisions required when the temporal decomposition ceases to preserve the object of inquiry.*

The record treats scale as a property of an analytical representation relative to a research question. Event, institutional, structural, and intergenerational time are therefore not assumed to divide the world into four natural layers. They identify temporal resolutions at which different changes may become empirically and historically tractable. The same organization, regulation, technology, or relation can participate in more than one resolution when different mechanisms or questions are under examination.

Proposition 23.102 (Scale-indexed historical answerability). *A multiscale GRE claim is historically answerable when the temporal resolutions it uses, the processes assigned to them, and the couplings asserted among them can be reconstructed and revised from historical evidence rather than being fixed solely for analytical convenience.*

Table 23.5 summarizes the principal temporal resolutions and interface responsibilities developed below.

Table 23.5: Principal temporal resolutions in the GRE–GRH multiscale interface

Temporal resolution	Typical analytical object	Economic relevance	Historical restraint
Event time	Decisions, shocks, announcements, transactions, protests, failures, interventions	Immediate reallocation, repricing, interruption, coordination, or change in expectations	Event boundaries and significance depend on prior relations and later transmission
Institutional time	Rules, routines, budgets, contracts, administrative cycles, organizational learning	Persistence, lagged adjustment, access conditions, authority, and recurrent allocation	Institutional clocks and revision rates can change historically
Structural time	Infrastructures, ownership patterns, durable position distributions, standards, production systems	Long-lived constraints, dependencies, capability distributions, and transition conditions	Slow change should not be equated automatically with structural importance
Intergenerational time	Assets, debt, knowledge, ecological conditions, institutional memory, durable obligations	Transmission of capacity, burden, opportunity, and constraint across successor cohorts or positions	Generational boundaries and carriers require domain-specific reconstruction
Cross-scale coupling	Relations among processes represented at different resolutions	Feedback, lag, amplification, buffering, and changing feasible sets	Coupling must be demonstrated rather than inferred from temporal coincidence

23.5.1 Event Time

Event time is the finest temporal resolution considered here. It concerns bounded occurrences whose ordering, duration, and immediate relational consequences matter to the economic inquiry. Examples can include a policy announcement, a contract termination, a payment failure, a strike, an emergency procurement decision, a platform rule change, a market interruption, or a sudden coordination event. Event time is not defined by short duration alone. A formally brief act can have no material economic consequence, while a process lasting several months can function analytically as an event when the research question concerns its relation to slower institutional or structural change.

Definition 23.103 (Event-time profile). An *event-time profile* records an event's analytical boundary, internal sequence, relevant participants and positions, pre-event configuration, immediate relational changes, contemporaneous uncertainty, available alternatives, evidential timestamps, and the pathways through which the event may transmit effects into slower temporal resolutions.

This profile keeps event analysis from becoming a chronology of salient dates. Historical prominence and economic significance are different properties. A highly visible announcement may leave allocation, capability, or institutional practice largely unchanged. A less visible procedural decision may alter access conditions for years. GRE therefore requires a transmission account before escalating a dated event into a broader economic explanation.

Definition 23.104 (Event transmission trace). An *event transmission trace* identifies the relations through which an event changes later states, the delay before those changes become observable, the positions through which transmission occurs, the forms of amplification or attenuation encountered, and the evidence distinguishing transmission from coincident change.

The trace also permits an event to be economically consequential through blocked transmission. A regulatory announcement can be historically important while failing to alter organizational practice because implementation resources, legal authority,

technical capacity, or local incentives prevent translation into institutional change. Such cases should remain visible rather than being classified simply as weak events.

Proposition 23.105 (Event-time transmission condition). *An event-time observation warrants a claim about slower economic transformation only when a transmission mechanism connects the event to the later institutional, structural, or intergenerational configuration and the relevant lag is consistent with the reconstructed sequence.*

Event time is therefore especially useful for locating initiation, interruption, trigger, and coordination. It is less adequate by itself for attributing persistence. Persistence becomes the object of the slower resolutions considered next.

23.5.2 Institutional Time

Institutional time concerns the recurrent temporal organization through which rules, routines, budgets, administrative procedures, contracts, standards, and organizational memory are reproduced or revised. Institutions possess several clocks at once. Budget cycles can be annual, leadership succession irregular, contracts multi-year, legal review episodic, and informal routines continuous. The relevant institutional time therefore depends on the mechanism under investigation rather than on a single calendar frequency.

Definition 23.106 (Institutional-time profile). *An institutional-time profile identifies an institution's recurrent cycles, revision opportunities, implementation lags, memory mechanisms, persistence horizons, decision bottlenecks, and the historical conditions under which those temporal properties were established or altered.*

Institutional time can buffer event volatility. A rapid price change or political announcement may be absorbed by procurement rules, reserve requirements, tenure protections, budgeting procedures, or professional routines. The same institutional architecture can also amplify event effects when a scheduled review, election, refinancing cycle, or regulatory deadline concentrates change into a narrow window.

Definition 23.107 (Institutional temporal memory). *Institutional temporal memory is the set of procedures, records, routines, commitments, material investments, and role expectations through which earlier institutional states continue to condition later decisions after the initiating events have passed.*

Memory in this sense is distributed. It can reside in archives, software, infrastructure, standardized forms, professional training, legal commitments, or expectations held by external actors. Institutional persistence therefore does not require unchanged personnel or explicit recollection by current decision makers.

Proposition 23.108 (Institutional-lag interpretation). *A lag between an event and an institutional response should be interpreted through the institution's historically reconstructed revision opportunities, commitments, and memory mechanisms rather than being treated automatically as inertia or inefficiency.*

Institutional time can itself accelerate or slow. Emergency powers may compress ordinary review cycles. Standardization can lengthen the persistence of a technical regime. Digital infrastructure can shorten coordination time while increasing the cost of changing deeply embedded software or data standards. Historical analysis is therefore required to determine whether a characteristic institutional rate remains stable across the period being modeled.

23.5.3 Structural Time

Structural time concerns transformations in durable configurations that organize many economic relations simultaneously. Relevant structures can include ownership distributions, transport or energy infrastructures, monetary architectures, production systems, labor-market segmentation, urban form, knowledge infrastructures, platform ecosystems, and persistent configurations of authority or dependence. Structural time is often slower than event or institutional time, yet slowness is neither necessary nor sufficient for structural status.

Definition 23.109 (Structural-time profile). A *structural-time profile* reconstructs the temporal formation, persistence, modification, and possible dissolution of a configuration whose relations condition multiple economic positions or processes beyond a single event or institutional cycle.

The definition makes scope and relational reach central. A slowly changing administrative routine can remain institution-specific, while a rapid collapse of payments infrastructure can become structurally consequential within days because it reorganizes exchange possibilities across many positions. Structural time should therefore be diagnosed through the temporal behavior of a structural relation, not equated with a predetermined duration.

Definition 23.110 (Structural persistence mechanism). A *structural persistence mechanism* is a relation or process through which a structural configuration reproduces enough of its position distribution, infrastructure, standards, dependencies, or conversion possibilities to condition later economic action despite local events and institutional turnover.

Structural persistence can coexist with continuous local change. Firms enter and exit while an ownership regime remains stable; technologies improve while dependence on a common standard deepens; individual contracts change while the bargaining structure governing them persists. The historical object is therefore the reproduction or transformation of the configuration, not the absence of movement within it.

Proposition 23.111 (Structural-time inference). A *claim of structural persistence or transformation should identify the configuration being preserved or changed, the mechanisms carrying that configuration across local turnover, and the evidence showing that the relevant relational reach exceeds the temporary state of particular actors or institutions.*

Structural time becomes especially important when apparent short-run flexibility depends on long-run constraints. An actor may switch suppliers quickly while remaining dependent on the same logistical infrastructure, legal regime, financing architecture, or technical standard. Multiscale analysis can therefore prevent local mobility from being mistaken for structural openness.

23.5.4 Intergenerational Time

Intergenerational time concerns economic effects carried across successor cohorts, organizational generations, institutional administrations, or other historically meaningful sequences of positions. Biological generations can be relevant, but they are not the only form. Public debt can bind later taxpayers; infrastructure can outlast its designers; knowledge systems can survive their founding communities; ecological degradation can shape economic possibilities for actors not present when the relevant

decisions were made.

Definition 23.112 (Intergenerational transmission profile). An *intergenerational transmission profile* identifies the earlier configuration, the carriers through which resources, capacities, obligations, knowledge, constraints, or ecological conditions are transmitted, the successor positions receiving them, the transformations occurring during transmission, and the evidence needed to distinguish inherited effects from conditions regenerated independently in the later period.

The carriers can be material, institutional, informational, legal, ecological, or relational. Their persistence need not be symmetric. An inherited asset can preserve value for one position while an inherited liability narrows another's options. Institutional memory can support continuity while also carrying exclusions forward. The relevant GRE question concerns how the inherited configuration changes later generative capacity, allocation, dependency, or feasible alternatives.

Definition 23.113 (Intergenerational temporal boundary). An *intergenerational temporal boundary* is the historically justified division used to distinguish predecessor and successor positions for a particular transmission question, together with the reasons that this division is analytically preferable to competing cohort, organizational, legal, or demographic boundaries.

This definition avoids assuming that a biological generation is the correct unit for every inquiry. A pension system, infrastructure project, environmental liability, or research institution can transmit effects over temporal intervals that do not align with demographic cohorts. The boundary should be chosen according to the transmission mechanism and then tested for robustness.

Proposition 23.114 (Transmission-based intergenerational claim). An *intergenerational GRE claim* is stronger when the transmitting carriers, successor positions, temporal boundary, and transformation of the inherited object are reconstructed explicitly rather than inferred from chronological succession alone.

Intergenerational time also creates a normative interface, because later positions can bear consequences without participating in the initiating decision. The present section records the temporal structure of that relation. Evaluation of legitimacy, rights, or justice remains subject to the disciplinary containment principles established earlier in Chapter 23.

23.5.5 Cross-Scale Coupling

The analytical value of multiple temporal resolutions lies primarily in their relations. Event effects can alter institutional revision; institutional routines can reproduce structural dependence; structural conditions can shape which events become consequential; intergenerational inheritances can constrain institutional choices long after the originating configuration disappears. These relations are forms of cross-scale coupling.

Definition 23.115 (Cross-scale historical coupling). A *cross-scale historical coupling* is a historically reconstructable relation through which a process represented at one temporal resolution materially alters the state, response, persistence, or transition conditions of a process represented at another temporal resolution.

Coupling can be directional or reciprocal. A crisis event may accelerate institutional change, while institutional design determines how future crises are absorbed.

Structural infrastructure can constrain event-level choices, while accumulated event-level decisions gradually modify the infrastructure. The strength and direction of coupling can also change across historical regimes.

Definition 23.116 (Cross-scale coupling profile). A *cross-scale coupling profile* identifies the source and receiving temporal resolutions, the interface variable or relation through which influence is transmitted, the lag and persistence of that influence, the direction and possible reciprocity of coupling, the conditions under which the coupling strengthens or weakens, and rival explanations for the observed co-movement.

The profile guards against an easy multiscale error: temporal correlation does not establish cross-scale mechanism. An institutional change can follow a market disruption because both respond to a third political, technological, or ecological development. Historical sequencing is necessary but insufficient. The interface relation must also be reconstructed.

Proposition 23.117 (Cross-scale attribution discipline). A *cross-scale causal interpretation* should identify a transmissive relation, temporally plausible ordering, and evidence capable of distinguishing coupling from shared exposure or coincident change at the relevant resolutions.

Cross-scale coupling also permits amplification and buffering to be studied relationally. A local event can remain local because institutional and structural configurations absorb it. Another event of similar immediate magnitude can produce wider transition because it arrives when institutional commitments are weak, structural dependencies are concentrated, or intergenerational burdens have accumulated. Multi-scale analysis therefore shifts attention from event magnitude alone to the receiving configuration.

23.5.6 Breakdown of Scale Separation

Analysts often simplify a historical-economic system by treating some processes as fast and others as slow. Such decomposition can be useful when characteristic response times differ enough that slower variables remain approximately stable over the faster process, or faster processes can be summarized when analyzing slower change. The usefulness of that approximation depends on the historical regime and coupling structure.

Definition 23.118 (Historical scale separation). *Historical scale separation* is an analytically justified approximation in which two or more processes have sufficiently different characteristic response or persistence horizons, under sufficiently limited cross-scale coupling over the research window, that they can be modeled at distinct temporal resolutions without materially distorting the claim under investigation.

The definition includes both rate difference and coupling. Large differences in nominal frequency do not guarantee separability. High-frequency financial transactions can exert cumulative influence on slower institutional balance sheets; slowly changing infrastructure can constrain each rapid transaction. Conversely, strong coupling at one historical moment can weaken after institutional reform, technological substitution, or organizational learning.

Definition 23.119 (Scale-separation breakdown record). A *scale-separation breakdown record* documents the prior temporal decomposition, evidence that characteristic rates or coupling strengths have changed, the mechanism producing the change,

the inference invalidated by the earlier decomposition, and the revised temporal representation required for the later regime.

Breakdown can occur through acceleration, deceleration, synchronization, or stronger cross-scale feedback. A crisis can compress years of institutional adjustment into weeks. A temporary emergency arrangement can persist and become structural. A technological platform can synchronize formerly separate organizational cycles. Ecological degradation can transform a previously slow background constraint into an immediate economic limit. Each case changes the temporal architecture of the explanation.

Proposition 23.120 (Conditional scale-separation rule). *Scale separation should be retained only while the reconstructed rate differences and coupling relations remain adequate for the claim being made; evidence of rate convergence, synchronization, or materially stronger cross-scale influence warrants revision of the temporal decomposition.*

The practical implication is methodological. A model calibrated in a stable regime may cease to be informative during transition precisely because the decomposition that made it tractable has failed. Model failure in such a case can reveal a historical change in temporal organization rather than only a parameter-estimation problem.

23.5.7 Historical Transition

Historical transitions are often dated by prominent events: a crisis, election, treaty, collapse, reform, technological release, or market opening. Multiscale reconstruction can show that the event date is only one temporal marker within a longer transition. Institutional implementation can precede or follow formal enactment, structural effects can accumulate over decades, and intergenerational consequences can become visible much later.

Definition 23.121 (Multiscale historical transition). *A multiscale historical transition is a historically reconstructed reconfiguration in which changes across two or more temporal resolutions alter the relations, persistence conditions, or feasible trajectories of an economic configuration enough that the earlier temporal decomposition or mechanism no longer provides an adequate account.*

This definition does not require simultaneous change. Lead-lag relations can be constitutive to the transition. Event-level disruption can precede institutional reform; institutional reform can precede structural reorganization; structural change can accumulate before an event makes it politically visible. The temporal sequence is therefore part of the explanatory object.

Definition 23.122 (Transition chronology matrix). *A transition chronology matrix records, for each relevant temporal resolution, the onset of detectable change, principal transition markers, periods of acceleration or reversal, stabilization or continued contestation, and the evidence linking changes across resolutions.*

A chronology matrix can also preserve disagreement. Historians, economists, legal scholars, and political theorists may date the same transition differently because they track different objects. Such disagreement need not be resolved into one authoritative date when the distinct dates correspond to real differences in event, institutional, structural, or normative transformation.

Proposition 23.123 (Plural dating of historical transition). *A multiscale transition*

may legitimately possess several analytically relevant dates when those dates correspond to distinct changes at different temporal resolutions and their relations are made explicit.

Historical transition can therefore be represented as a process with internal temporal structure rather than as a point separating two equilibria. This is especially important for GRE because the value, capability, power, and option structures of a transition can change before a new institutional or structural configuration becomes stable.

23.5.8 Economic Interpretation

Multiscale historical reconstruction becomes part of GRE when temporal distinctions change an economic claim. Historical detail alone does not require an economic interpretation, and an economic interpretation should identify which GRE object is altered by the historical timing. Relevant objects can include allocation, capability, value generation and conversion, circulation, generative return, dependency, power, feasible alternatives, institutional access, and the persistence of economic relations.

Definition 23.124 (Multiscale economic interpretation bridge). A *multiscale economic interpretation bridge* specifies how a historically reconstructed temporal relation changes the identification, measurement, mechanism, comparison, or evaluation of an economic object, together with the historical remainder that should not be reduced to the economic interpretation.

The bridge prevents temporal vocabulary from functioning as explanation by itself. Calling a process “slow,” “structural,” or “intergenerational” does not explain an economic consequence. The analysis should show, for example, how a lag changes access to credit, how infrastructure persistence alters feasible production choices, how institutional memory redistributes bargaining capacity, or how inherited ecological conditions alter later opportunity sets.

Definition 23.125 (Economic multiscale relevance criterion). A historical temporal distinction satisfies the *economic multiscale relevance criterion* when incorporating that distinction materially changes at least one economic object, mechanism, comparison, or warranted inference relative to an otherwise comparable analysis that omits it.

This criterion also helps limit unnecessary complexity. A research project need not represent every temporal resolution merely because several can be imagined. Additional scales should enter when they change the economic answer or the uncertainty surrounding it.

Proposition 23.126 (Economic interpretation proportionality). *The complexity of a multiscale economic interpretation should be proportionate to the historical distinctions required to preserve the relevant economic mechanism, comparison, or uncertainty; additional temporal layers require an identifiable analytical contribution.*

Economic interpretation remains bidirectional. GRE can ask GRH for more precise periodization or transmission history, while GRH can return evidence that the economic categories themselves changed during the period. In the latter case, the appropriate response may be category revision rather than the addition of another time scale to an unchanged model.

23.5.9 Formal Hypotheses and Ontological Restraint

Formal representation can make multiscale hypotheses explicit, particularly when research concerns lagged coupling, memory, response horizons, or changing rate regimes. The representation developed here is deliberately minimal. It provides notation for candidate historical-economic mechanisms while leaving open whether the empirical object is better represented by discrete events, continuous processes, networks, institutions, narratives, or another formal architecture.

Definition 23.127 (Analytical temporal index set). Let $\mathcal{K} = \{e, i, s, g\}$ denote an *analytical temporal index set*, where the labels refer respectively to event, institutional, structural, and intergenerational resolutions. For each $k \in \mathcal{K}$, let $x_k(t) \in X_k$ denote a research-defined state representation at time t . The spaces X_k and their elements are analytical constructions whose contents must be specified by the empirical study.

The notation does not imply that four corresponding substances or ontological levels exist. It records a decision to represent selected historical-economic processes at four temporal resolutions. Different studies can omit a resolution, divide one resolution further, or replace the index set when evidence supports a different decomposition.

When cross-scale influence is delayed or historically distributed, a coupling input from resolution ℓ to resolution k can be represented by Equation 23.1.

$$c_{k \leftarrow \ell}(t) = \int_0^{H_{k\ell}} K_{k\ell}(u) \phi_{\ell \rightarrow k}(x_\ell(t-u)) du. \quad (23.1)$$

Here $H_{k\ell}$ is the historically relevant memory horizon, $K_{k\ell}(u)$ is a weighting kernel describing how influence varies with lag u , and $\phi_{\ell \rightarrow k}$ is an explicitly specified interface map translating features represented at resolution ℓ into quantities meaningful for the receiving representation at resolution k . A discrete-time sum can replace the integral when the evidence is event-based or observed at discrete intervals.

Hypothesis 23.128 (Delayed cross-scale coupling). *For a specified historical-economic process, a model that represents an empirically supported lagged interface between two temporal resolutions may account for the reconstructed transition more adequately than an otherwise comparable model restricted to contemporaneous coupling, provided that the additional memory structure improves discrimination rather than merely absorbing unexplained residual variation.*

Equation 23.1 can enter a scale-specific transition representation. One minimal form is stated in Equation 23.2.

$$x_k(t + \Delta_k) = F_k(x_k(t), \{c_{k \leftarrow \ell}(t)\}_{\ell \in \mathcal{K}, \ell \neq k}, q_k(t); \theta_k). \quad (23.2)$$

Here Δ_k is the temporal resolution selected for process k ; F_k is a research-specified transition map; $q_k(t)$ collects contextual inputs represented outside the cross-scale state set; and θ_k denotes parameters, rules, or historically fixed assumptions of the chosen model. The equation is a template for hypothesis construction, not a claim that every historical-economic process follows a smooth or stationary transition law.

Characteristic response horizons can also be allowed to vary through history. For two represented processes k and ℓ , Equation 23.3 defines a simple dimensionless rate-

separation indicator.

$$\rho_{k\ell}(t) = \frac{\min\{\tau_k(t), \tau_\ell(t)\}}{\max\{\tau_k(t), \tau_\ell(t)\}}, \quad 0 < \rho_{k\ell}(t) \leq 1, \quad (23.3)$$

where $\tau_k(t)$ and $\tau_\ell(t)$ are empirically or interpretively justified characteristic response horizons. A small value of $\rho_{k\ell}(t)$ indicates strong rate separation, while a value approaching one indicates similar characteristic horizons. Equation 23.3 does not by itself establish scale separation because strong cross-scale coupling can remain material even when characteristic rates differ greatly.

Hypothesis 23.129 (Regime-dependent scale separation). *For historical periods in which the response horizons $\tau_k(t)$, $\tau_\ell(t)$, or the coupling represented by $c_{k \leftarrow \ell}(t)$ change materially, a model that permits time-varying scale separation may outperform a model that fixes fast and slow classifications across the entire period.*

The hypothesis is intentionally testable and limited. It can fail because the temporal decomposition is unnecessary, because observed rate changes are measurement artifacts, because another mechanism explains the transition, or because the chosen scale labels do not preserve the historically relevant object.

Definition 23.130 (Formal multiscale hypothesis record). *A formal multiscale hypothesis record specifies the temporal index set, state representations, empirical meanings of the represented quantities, assumptions required by the transition and coupling structures, evidence used to identify lags or response horizons, competing representations, validation criteria, and the historical regimes beyond which the formalization should not be presumed stable.*

Definition 23.131 (Multiscale ontological restraint record). *A multiscale ontological restraint record distinguishes what the formal representation assumes for analytical tractability from what the inquiry is prepared to claim about the constitution of historical-economic reality, including any scale, state, continuity, separability, or causal assumptions that remain representational rather than ontological commitments.*

The restraint record is especially important when formal languages imported from dynamical systems, statistical physics, field theory, network science, or other mathematical traditions are used. Successful representation can support claims about predictive adequacy, reconstruction, comparison, or mechanism under stated assumptions. It does not by itself establish that historical economies literally possess the ontology associated with the originating physical or mathematical model.

Proposition 23.132 (Formal–ontological separation in multiscale history). *Empirical success of a multiscale formalization warrants stronger confidence in the represented relations only to the extent supported by its identification and validation; it does not by itself establish that the analytical temporal resolutions, state spaces, kernels, or transition maps constitute the ultimate ontology of the historical-economic process.*

Definition 23.133 (Multiscale historical interface portfolio). *A multiscale historical interface portfolio is a versioned collection of event-time profiles, institutional and structural time profiles, intergenerational transmission profiles, coupling profiles, scale-separation breakdown records, transition chronology matrices, economic interpretation bridges, formal hypotheses, and ontological-restraint records maintained across related GRE–GRH inquiries.*

Proposition 23.134 (Multiscale historical-interface answerability). *A multiscale GRE–*

GRH analysis is answerable when each temporal resolution has an explicit empirical or interpretive role, cross-scale couplings are historically reconstructable, breakdown of scale separation can trigger model revision, economic interpretation is proportionate to the mechanisms affected, and formal representations remain distinguishable from ontological claims.

Multiscale historical inquiry therefore extends the GRE–GRH interface by making temporal heterogeneity itself inspectable. Events, institutions, structures, and inter-generational transmissions can be studied at different resolutions while their couplings remain part of the explanatory object. Historical transitions can alter both the states being modeled and the temporal decomposition used to model them. These results provide the temporal groundwork for the subsequent governance interface, where institutional response horizons, adaptation, and cross-frequency mismatch become questions of governance as well as economic analysis.

23.6 Generative Relational Governance Interface

Sections 23.4 and 23.5 developed the historical interface through which GRE can receive corrections concerning formation, sequence, temporal resolution, and multi-scale change. The present section establishes the corresponding interface with Generative Relational Governance (GRG). Its role is to distinguish economic conditions that generate governance problems from governance questions whose principal warrant concerns authority, legitimacy, participation, institutional coordination, collective decision, or the revision of governing arrangements. The objective is not to construct GRG inside GRE. It is to specify how economic findings concerning relations, generative processes, constraints, capacities, power, value circulation, and temporal change enter governance inquiry; how governance arrangements return economically consequential effects; and where GRE must stop and defer. The discussion proceeds through economic conditions of governance, governance of economic relations and generative processes, adaptive and field governance, institutional learning, governance under uncertainty, and explicit limits on GRE governance claims. The method is relational and interface-oriented. Earlier GRE governance architectures remain available as economic descriptions, while claims whose warrant depends materially on governance-specific concepts are transferred for independent GRG analysis.

Definition 23.135 (GRE–GRG interface record). *A GRE–GRG interface record specifies an economically consequential configuration that raises a governance question, the GRE findings entering the interface, the governance-specific objects that require independent analysis, the direction of translation, affected and governing positions, authority and participation structures where known, temporal and scale conditions, unresolved normative or institutional questions, expected return corrections, and the GRE claims that would require revision if GRG analysis changes the interpretation of the case.*

The interface record treats governance as more than implementation of an economic recommendation. GRE may identify a relation whose maintenance is underprovided, a value-circulation pathway whose capture is concentrated, or a capability asymmetry whose consequences are persistent. Those findings can generate governance questions without determining who should govern, by what authority, through which procedures, or with what standards of legitimacy. Conversely, governance ar-

Table 23.6: Principal operations at the GRE–GRG governance interface

Interface object	GRE contribution	GRG question	Return to GRE
Governance conditions	Resources, dependencies, constraints, capabilities, asymmetries, temporal pressures	What governing arrangement is justified and institutionally competent?	Revised interpretation of feasible and legitimate economic action
Economic relations	Formation, maintenance, exit, membership, higher-order relation effects	Who may authorize, alter, review, or terminate governing rules?	Changes in relational incidence, access, and option structure
Generative processes	Allocation, conversion, circulation, return, regeneration, capture, dissipation	Which process stages warrant governing intervention and by what authority?	Revised process boundaries, responsibilities, and economic consequences
Adaptive governance	Monitoring, evidence, reversibility, path dependence, response horizons	How should revision authority, safeguards, and accountability be organized?	Revised adaptation costs, institutional capacities, and reachable futures
Field governance	Distributed positions, infrastructures, dependencies, cross-scale coupling	How should polycentric or distributed governing relations be coordinated?	Revised field boundaries, control points, and economic propagation pathways
Institutional learning	Evidence flows, implementation results, organizational memory, capability change	Who may interpret evidence and convert learning into rule revision?	Revised models of institutional adaptation and economic persistence
Uncertainty	Model uncertainty, incomplete observation, scenario dispersion, irreversibility	Which procedures remain legitimate and revisable under unresolved uncertainty?	Revised decision boundaries, monitoring needs, and economic safeguards
Scope limit	Economic stakes and consequences	Authority, legitimacy, public justification, collective standing, constitutional ordering	Domain correction, reclassification, or narrowed GRE claim

rangements can constitute the economic field by defining membership, review, access, rule-change procedures, representation, infrastructural obligations, or permissible forms of coordination. The interface is therefore bidirectional.

Proposition 23.136 (Economic–governance handoff condition). *A GRE inquiry should hand a material subquestion to GRG when resolution of that subquestion depends principally on the justification, allocation, exercise, contestation, or revision of governing authority rather than on economic description, economic mechanism, or economic consequence alone.*

Proposition 23.136 does not require GRE to become silent once a governance question appears. Economic analysis can continue to identify resources, dependencies, opportunity costs, incidence, temporal constraints, institutional capacities, power effects, or feedback. The handoff concerns the source of warrant for the governance conclusion. It therefore preserves the containment principle of Section 23.2 while keeping the interface open to return correction.

Table 23.6 summarizes the principal interface operations developed below.

23.6.1 Economic Conditions of Governance

Governance problems often become visible through economic conditions before they can be resolved as governance questions. Scarce maintenance resources can make formally protected rights difficult to exercise. Infrastructure ownership can place practical gatekeeping capacity in private hands. High exit costs can turn nominally voluntary relations into persistent dependencies. Rapid technical change can outpace institutional review. Unequal access to expertise or data can change whose claims become governable. These are economic conditions because they concern resources,

capacities, constraints, dependencies, and opportunity structures. Their existence can create governance demand without specifying the legitimate response.

Definition 23.137 (Economic governance profile). An *economic governance profile* records the resources, capacities, constraints, dependencies, asymmetries, infrastructures, temporal pressures, value flows, affected positions, and foreseeable economic consequences that materially condition whether and how a governance problem can be addressed.

The profile is deliberately broader than a fiscal or budget analysis. Governance capacity can depend on staffing, information, technical interoperability, organizational competence, public trust, translation, monitoring, repair capability, or the practical availability of alternatives. These conditions can be distributed across several institutions. A governing body can possess formal authority while lacking the economic or organizational capacity needed to make that authority consequential. Conversely, an actor without formal public authority can possess infrastructural or informational capacities that strongly condition the feasible governing field.

This distinction helps prevent two opposite errors. One is to infer governance legitimacy from economic capacity: possession of resources or control does not by itself establish a right to govern. The other is to discuss governance as if institutional authority could operate independently of material capacity. A rule that cannot be observed, implemented, maintained, contested, or repaired may remain formally valid while weakly governing the economic relation in practice.

Proposition 23.138 (Governance-capacity non-equivalence). *Economic capacity to implement, enforce, monitor, or revise a governing arrangement does not by itself establish legitimate governing authority, while legitimate authority does not by itself establish the economic capacity required for effective governance.*

The proposition creates an explicit interface. GRE can investigate the economic preconditions and consequences of governance capacity. GRG must examine the authority and justification through which such capacity may properly be exercised. A complete interface analysis requires both where the distinction is material.

23.6.2 Governance of Economic Relations

The earlier substantive GRE treatment of governance in Chapter 16 developed governance of relations as an economic problem. The present interface revisits that architecture at the disciplinary boundary. Economic relations can be governed through contracts, standards, organizational rules, platform architecture, professional norms, public regulation, community practices, collective bargaining, or combinations of these. GRE can reconstruct how such arrangements affect relation formation, maintenance, transformation, exit, membership, and higher-order dependence. GRG becomes necessary when the question turns to who may set or alter those rules, how affected positions acquire standing, what forms of participation or contestation are adequate, or which governing relation is justified.

Definition 23.139 (Economic-relation governance interface). An *economic-relation governance interface* records an economic relation, the rules and infrastructures conditioning its formation and operation, the positions authorized or able to alter those conditions, participation and review pathways, economic incidence, exit and dependency conditions, unresolved governance questions, and the corrections that governance analysis may return to the economic account.

This representation distinguishes governance *of* a relation from governance *through* a relation. An employment relation can itself be governed by law, contract, organizational procedure, and collective bargaining. The same relation can also govern access to income, insurance, information, professional standing, or future opportunity. A platform-client relation can be subject to external regulation while simultaneously governing access, ranking, data visibility, and dispute procedures for participants. GRE should therefore trace both directions when they change economic capability or dependence.

Governance also enters relational exit. The earlier relational-governance analysis treated exit as more than formal termination. Practical exit can depend on portability, alternative infrastructure, debt, information, switching cost, social protection, legal continuity, or the preservation of accumulated capacities. GRG can add questions about procedural fairness, authority, voice, representation, or duties of transition. The economic and governance analyses overlap without becoming identical.

Proposition 23.140 (Relational governance dual-accountability). *Where a governing arrangement materially conditions an economic relation, adequate interface analysis should identify both its economic incidence on affected positions and the governance structure through which the relevant rules are authorized, contested, reviewed, and revised.*

This dual accountability prevents an efficient or stable relation from being treated as sufficiently governed merely because its economic outputs are favorable, and it prevents a formally well-authorized arrangement from being treated as economically adequate when its incidence generates persistent exclusion, dependency, or capacity loss.

23.6.3 Governance of Generative Processes

The earlier substantive GRE treatment developed governance of generative processes across allocation, propagation, conversion, circulation, return, accumulation, extraction, dissipation, transformation, and capture. The cross-domain question is narrower: which parts of that analysis remain economic, and which require governance theory once intervention into a generative process becomes institutionally consequential?

GRE can identify a process stage at which value is systematically captured, return is interrupted, conversion costs are concentrated, or regenerative capacity deteriorates. Such findings can support a claim that a process is economically consequential and that its governing conditions deserve investigation. They do not alone determine whether the process should be restricted, redistributed, redesigned, publicly governed, collectively governed, left decentralized, or governed through some hybrid arrangement.

Definition 23.141 (Generative-process governance interface). *A generative-process governance interface specifies the economic process under examination, its stages and carriers, the points at which governing arrangements can alter initiation, direction, rate, pathway, conversion, circulation, return, capture, or termination, the affected positions, the economic consequences of alternative arrangements, and the governance questions whose resolution requires authority or legitimacy analysis beyond GRE.*

The interface is particularly important where a process has several desirable and

undesirable consequences at once. A knowledge-production system can generate epistemic value while concentrating ownership of infrastructure. A platform can reduce coordination costs while increasing dependence on a private rule architecture. A policy can accelerate investment while narrowing future reversibility. A return obligation can support source-side regeneration while imposing administrative burdens that exclude small participants. Governing the generative process therefore requires a profile of plural consequences rather than a single optimization target.

Proposition 23.142 (Process-governance non-deduction). *An economically diagnosed failure or asymmetry in a generative process can justify opening a governance inquiry without, by itself, determining the legitimate governing form, governing authority, or permissible distribution of decision rights.*

This proposition is a direct containment rule. GRE contributes the process diagnosis and economic consequence profile. GRG must examine the governing architecture where the conclusion depends on public justification, authority, representation, or collective decision.

23.6.4 Adaptive Governance

Adaptive governance is already present inside GRE as an economic object. Earlier chapters developed monitoring, feedback, experimentation, reversibility, distributed learning, rule evolution, historical re-evaluation, and co-evolution for economic governance. The GRG interface becomes necessary because adaptation changes more than policy parameters. It can change who has authority, which evidence counts, which groups carry burdens, how quickly rules can be revised, and which commitments remain protected against rapid change.

The multiscale analysis of Section 23.5 adds an important temporal restraint. Governance can respond too slowly to rapidly changing economic processes, but it can also respond too quickly relative to slower social, institutional, or intergenerational consequences. Adaptive capacity is therefore not equivalent to maximal response speed. The specific frequency-domain problem is reserved for the next section; the present subsection establishes the broader interface.

Definition 23.143 (Adaptive-governance handoff profile). *An adaptive-governance handoff profile records the changing economic condition, monitoring and evidence pathways, response horizon, reversibility, affected positions, institutional capabilities, rule-change mechanisms, commitments requiring continuity, uncertainty, and the questions of authority, participation, accountability, and legitimate revision that require GRG analysis.*

A governance arrangement can be economically adaptive while normatively or institutionally problematic. It may respond rapidly because decision authority is concentrated and contestation is weak. Another arrangement may be procedurally inclusive but unable to process evidence before irreversible harm accumulates. The interface therefore needs both adaptation performance and governance quality. Neither can substitute for the other.

Proposition 23.144 (Adaptive-governance double criterion). *A claim that an adaptive governance arrangement is adequate requires separate support for its capacity to respond to materially changing economic conditions and for the governance procedures through which response authority, participation, accountability, and protected commitments are organized.*

The distinction also makes revision historically inspectable. A successful adaptation can still expose a weakness in the original governing arrangement. GRG feedback can therefore return to GRE by changing how economic adaptation costs, coordination capacities, institutional frictions, or feasible response horizons are modeled.

23.6.5 Field Governance

Many economic-governance problems do not have a single governing center. Firms, public agencies, standards bodies, courts, communities, infrastructures, professional organizations, technical systems, and affected groups can each exercise partial governing capacity over different aspects of the same economic field. GRE can represent these distributed relations through positions, dependencies, infrastructures, power mechanisms, and propagation pathways. GRG is needed to analyze the governing architecture produced by the interaction of those partial authorities and capacities.

Definition 23.145 (Field-governance interface map). A *field-governance interface map* represents the governing positions relevant to an economic field, the domains and objects over which each position exercises formal or practical influence, interdependencies among governing sites, coordination and conflict pathways, affected but weakly represented positions, economic propagation channels, and the unresolved questions of authority, legitimacy, accountability, and institutional design.

The term *field* remains an analytical representation rather than an ontological claim. Its use is warranted when the research question requires analysis of distributed and mutually conditioning governing relations that cannot be adequately described as one principal-agent hierarchy or one organization. The map can therefore include overlapping public and private authority, technical standards, market dependence, legal review, informal coordination, and community practice without assuming that these components form a unified governing system.

Field governance can generate coordination gains while also diffusing responsibility. A harmful outcome may result from the interaction of several locally reasonable rules, none of which controls the whole configuration. Conversely, distributed governance can create redundancy, experimentation, local knowledge, and checks on concentrated authority. GRE can investigate the economic effects of these structures. GRG must examine how accountability, conflict resolution, subsidiarity, representation, and meta-governance should operate across them.

Proposition 23.146 (Distributed-governance attribution condition). *In a distributed governance field, attribution of an economic outcome to a governing position should identify the mechanism and scope of that position's influence, the relevant dependencies on other governing sites, and the counterfactual role of coordination or non-coordination rather than treating formal jurisdiction as sufficient evidence of causal control.*

This condition is economic and governance-relevant at once. It helps GRE avoid overstating causal control, and it gives GRG a clearer object for examining responsibility and institutional design.

23.6.6 Institutional Learning

Institutions can collect evidence, preserve memory, revise procedures, and alter rules. Yet information acquisition does not automatically become institutional learn-

ing. Learning requires a pathway through which evidence changes interpretation, capability, routine, decision rule, governing arrangement, or future observation. GRE can study the resources, infrastructures, organizational capacities, incentives, and economic consequences involved in that pathway. GRG becomes necessary where the question concerns which institutions may interpret evidence authoritatively, whose experience receives standing, how disagreement is preserved, and how learning may legitimately change governing rules.

Definition 23.147 (Learning-to-authority trace). A *learning-to-authority trace* reconstructs how evidence or experience is generated, recorded, interpreted, translated across institutional boundaries, assigned standing, connected to an authorized review process, incorporated or rejected, and converted into a change in governing practice, while preserving unresolved disagreement and the economic consequences of the resulting revision.

The trace distinguishes epistemic availability from governing uptake. A frontline institution may know that an access rule is failing while lacking authority to alter it. A regulator may possess formal authority while receiving delayed or aggregated evidence that removes the local mechanism. A community may hold situated knowledge that is visible only through procedures that the governing institution does not recognize as valid evidence. Learning failure can therefore occur at generation, preservation, translation, standing, authority, or implementation.

The section also retains the re-epistemization discipline developed earlier in the book. An institution can revise a prior rule because later evidence changes its warrant without implying that the earlier decision was irrational given what was then knowable. Governance learning benefits from preserving this version history because it supports responsibility, repair, and future institutional memory.

Proposition 23.148 (Institutional-learning conversion condition). *Evidence becomes governance-relevant institutional learning only when a traceable pathway connects its generation and interpretation to a change in institutional understanding, capability, rule, procedure, or future observation, with the authority and accountability for that conversion made explicit.*

GRG correction can return here by changing GRE's assumptions about institutional response capacity. If governance analysis shows that evidence lacks standing, authority is fragmented, or review procedures structurally filter certain positions, an economic model that assumes frictionless institutional updating should be revised.

23.6.7 Governance under Uncertainty

GRE repeatedly operates under uncertainty concerning measurement, causal mechanisms, future trajectories, heterogeneous values, model adequacy, and the behavior of interacting institutions. Governance does not remove those uncertainties. It organizes collective action while some of them remain unresolved. Economic analysis can compare scenarios, costs, dependencies, reversibility, option preservation, monitoring value, or distribution of exposure. GRG must address the procedures and authority through which action is justified when evidence is incomplete and disagreement persists.

Definition 23.149 (Governance-uncertainty profile). A *governance-uncertainty profile* records the material uncertainties relevant to an economic-governance question, their sources and possible reducibility, affected positions, distribution of exposure,

reversibility, information latency, monitoring options, alternative actions, disagreement, institutional response capacity, and the governance procedures through which commitment, review, escalation, or restraint may be justified.

Several kinds of uncertainty should remain distinguishable. Epistemic uncertainty concerns incomplete knowledge about the present configuration or mechanism. Stochastic uncertainty concerns variation represented probabilistically. Model uncertainty concerns disagreement among representations. Historical uncertainty can concern missing records or contested reconstruction. Normative uncertainty concerns unresolved evaluation. Strategic uncertainty arises when governed actors respond to the governance process itself. These forms can interact but should not be collapsed into one scalar confidence level.

Uncertainty can also be asymmetrically distributed. Some positions may face irreversible consequences while others face mainly financial variance. Some possess information needed to adapt while others learn only after harm occurs. Governance under uncertainty therefore includes distribution of epistemic access, exposure, waiting costs, and capacity to revise. GRE can make these asymmetries visible; GRG must address their governance significance.

Proposition 23.150 (Uncertainty-governance non-substitution). *Economic techniques for robustness, option preservation, monitoring, or expected consequence cannot substitute for governance analysis where commitment under uncertainty depends materially on authority, standing, legitimacy, burden allocation, or procedures for later revision.*

The proposition preserves a useful division of labor. Economic analysis can help compare consequences and identify where uncertainty matters. Governance analysis must examine who may act, whose risks count, how disagreement is processed, and how commitments remain contestable and revisable.

23.6.8 Limits of GRE Governance Claims

The preceding subsections show that GRE can make substantial contributions to governance inquiry. It can identify economic conditions of governing capacity, reconstruct the incidence of governing rules on economic relations, analyze process-level intervention points, estimate adaptation costs and response horizons, map distributed economic influence, examine institutional learning capacities, and characterize uncertainty and exposure. These contributions remain economically bounded. They do not independently establish legitimate authority, public justification, constitutional standing, political representation, the moral priority of competing claims, or the proper constitution of a governing community.

Definition 23.151 (GRE governance-claim boundary). The *GRE governance-claim boundary* is the point at which an inference from economic structure, mechanism, capacity, consequence, or constraint to a governance conclusion would require a material premise concerning authority, legitimacy, collective standing, public justification, constitutional ordering, or governance-specific normativity that GRE has not independently established.

This boundary is claim-relative rather than topic-relative. GRE can legitimately study a public institution's budget, capability, infrastructure, relational incidence, or economic effects. It crosses the boundary when those findings are treated as sufficient to settle the institution's legitimate authority. GRE can show that a governance

arrangement concentrates economic dependence. It does not follow that one particular constitutional remedy is established. GRE can show that a slower review process preserves some long-horizon options while increasing short-horizon exposure. The legitimate balance among those consequences remains a governance question unless the relevant normative and authority premises have been supplied from an appropriate domain.

The interface must also permit return correction. GRG may show that an economic category misidentifies the governing unit, that the relevant authority is distributed rather than centralized, that participation changes the object being governed, that institutional legitimacy constrains feasible policy, or that the economic model has treated a governance commitment as an exogenous parameter when it is historically constitutive. Such findings should be allowed to revise GRE.

Definition 23.152 (GRG correction return). A *GRG correction return* records a governance finding that materially changes a GRE boundary, category, mechanism, feasible-set assumption, temporal horizon, institutional representation, or interpretation of an economic consequence, together with the evidence and reasoning supporting that correction and the GRE claims requiring revision.

Definition 23.153 (GRE–GRG interface portfolio). A *GRE–GRG interface portfolio* is a versioned collection of governance-condition profiles, economic-relation interfaces, generative-process interfaces, adaptive-governance handoffs, field-governance maps, learning-to-authority traces, uncertainty profiles, unresolved governance remainders, and GRG correction returns maintained across cases and research projects.

The portfolio supports cumulative comparison without presuming a completed unified theory. Recurrent economic conditions can reveal stable governance questions. Recurrent correction returns can expose systematic blind spots in GRE. Repeated non-transfer can identify genuine disciplinary boundaries. Over time, these records can support stronger cross-domain hypotheses, but only after the relevant domains have independently tested them.

Proposition 23.154 (GRE–GRG interface answerability). A *GRE governance claim* is cross-domain answerable when the economic basis of the claim, the governance-specific premises it requires, the handoff boundary, the unresolved remainder, and the possible GRG correction return are explicit enough that contrary governance analysis can narrow, revise, or reclassify the GRE inference.

The proposition completes the general GRE–GRG interface. The next section narrows the problem to temporal mismatch among economic dynamics and governing response, asking when differences in characteristic frequency or response horizon become economically consequential and which parts of that diagnosis properly belong to governance theory.

23.7 Frequency-Domain Governance Interface

The multiscale historical analysis of Section 23.5 and the GRE–GRG interface of Section 23.6 jointly raise a more specific question: what happens when economically consequential processes and governing processes operate with materially different characteristic response horizons? The role of the present section is to formulate that question as an interface problem rather than as a self-contained theory of governance. Its objective is to distinguish economic diagnostics of temporal mismatch from

governance conclusions concerning authority, legitimacy, procedural cadence, or institutional redesign. The discussion proceeds through multiple dynamical frequencies, governance horizons, temporal mismatch, cross-frequency coupling, synchronization and desynchronization, institutional response times, economic questions, and questions deferred to GRG. The method combines multiscale economic interpretation with restrained formalization. The term *frequency-domain* is used here in an analytical sense: a process can be characterized by a rate, recurrence interval, adjustment horizon, or response time without being assumed to be literally periodic or adequately represented by a Fourier decomposition. Table 23.7 summarizes the principal interface operations developed below.

Definition 23.155 (Frequency-domain governance interface record). A *frequency-domain governance interface record* specifies an economic process and a governing process whose characteristic temporal responses are being compared, the empirical or interpretive basis for their response horizons, observation resolution, relevant lags and memory, coupling pathways, affected positions, economic consequences of relative timing, uncertainty, candidate adaptation mechanisms, governance-specific questions, and the GRE claims that would require revision if GRG analysis changes the interpretation of the governing response.

The record prevents a temporal metaphor from becoming a conclusion. A market price can update in seconds while prudential review takes months; a platform ranking system can change daily while employment law changes over years; ecological degradation can accumulate over decades while procurement or investment decisions are revised quarterly. These differences can matter economically, but the fact that one process is faster does not establish that governance should accelerate. Slow response can reflect incapacity, institutional memory, due process, legal constraint, deliberative protection, or a deliberate commitment to stability. Fast response can improve adaptation in one setting while amplifying volatility or short-horizon incentives in another.

Definition 23.156 (Analytical process frequency). For a process p with a research-justified characteristic response horizon $\tau_p(t) > 0$, its *analytical process frequency* is the reciprocal quantity defined in Equation 23.4.

$$f_p(t) = \frac{1}{\tau_p(t)}. \quad (23.4)$$

Equation 23.4 provides a convenient common unit for comparing processes whose characteristic adjustment horizons differ. A higher value of $f_p(t)$ indicates a shorter characteristic response horizon. The definition does not imply periodic recurrence, stationarity, or a unique natural frequency. The horizon $\tau_p(t)$ may itself vary historically, as emphasized by Equation 23.3 and the regime-dependent scale-separation hypothesis of Section 23.5.

23.7.1 Multiple Dynamical Frequencies

Economic configurations contain processes with heterogeneous characteristic rates. Payment systems can settle within seconds; inventory decisions may adjust over days; wage contracts can persist for months or years; capital infrastructure can remain in place for decades; demographic and ecological effects may unfold over generations. Even within one institution, information, authorization, implementation, and learn-

Table 23.7: Principal operations in the frequency-domain governance interface

Interface object	Economic diagnostic	Governance question	Interface limit
Dynamical frequency	Characteristic adjustment or response horizon	Which temporal processes should governance recognize?	Frequency is analytical unless periodicity is independently established
Governance horizon	Detection, review, authorization, implementation, feedback, revision	Which cadence is institutionally and normatively appropriate?	Faster response does not by itself imply better governance
Temporal mismatch	Direction and magnitude of relative response delay	Is mismatch acceptable, remediable, or constitutive of due process?	Economic cost cannot settle legitimacy
Cross-frequency coupling	Lagged influence across processes with different rates	Which couplings warrant governing attention?	Coupling does not establish authority
Synchronization	Alignment sufficient for a specified governing function	Which forms of alignment should be pursued or resisted?	Synchronization is task-relative, not a universal objective
Desynchronization	Persistent lag, overshoot, missed windows, or unstable feedback	Which institutional changes are justified?	Diagnosis does not determine constitutional remedy
Institutional response time	Response-chain latency and bottlenecks	Who may change the response chain and under what safeguards?	Capacity analysis remains distinct from authority
Economic scope	Costs, incidence, volatility, dependence, options, investment, distribution	What economic consequences follow from timing?	GRE retains economic answerability
GRG handoff	Economic stakes made explicit	Legitimacy, standing, procedural cadence, emergency authority, review	Governance warrant remains external to GRE

ing can proceed at different rates. A frequency-domain perspective becomes useful when those differences alter interaction, transmission, adaptation, or the interpretation of observed outcomes.

Definition 23.157 (Dynamical-frequency profile). *A dynamical-frequency profile records, for each process material to a specified research question, its characteristic response horizon, empirical or interpretive basis, variability through time, observation resolution, relevant lags, recurrence or persistence where applicable, and the uncertainty associated with assigning the process to a temporal rate band.*

The profile should preserve heterogeneity rather than forcing every process into a single temporal metric. Some processes admit high-frequency measurement but have slow substantive adjustment. Others change rapidly but are observed only through infrequent surveys or administrative records. Observational frequency and process frequency therefore require separation. Daily data do not prove daily structural adjustment, and annual data do not prove that the underlying process changes only annually.

Frequency labels should also be scale-relative. A quarterly adjustment may be slow relative to algorithmic repricing and fast relative to infrastructure renewal. The labels *high*, *medium*, and *low* frequency therefore have meaning only against a stated comparison set and research problem.

Proposition 23.158 (Frequency relativity). *A classification of an economic process as high- or low-frequency is analytically warranted only relative to a specified comparison set, response-horizon criterion, and research question; the classification should be revised when those conditions change materially.*

The proposition extends the scale-relative discipline of Section 23.5. It also protects the governance interface from a common simplification: a process described as “fast”

in one research design need not justify accelerated governance in another.

23.7.2 Governance Horizons

Governance itself has temporal structure. A governing arrangement must observe or receive signals, interpret them, establish standing or agenda priority, authorize action, implement a response, receive feedback, and sometimes revise the rule. Different stages may have different durations and different institutional owners. The relevant governance horizon is therefore rarely identical to a statutory deadline or meeting interval.

Definition 23.159 (Governance-horizon profile). A *governance-horizon profile* records the characteristic temporal intervals associated with detection, interpretation, agenda formation, authorization, implementation, feedback, review, appeal, and revision for a specified governing arrangement, together with their institutional owners, dependencies, uncertainty, and conditions under which the intervals may shorten, lengthen, or become discontinuous.

A profile can reveal several distinct sources of apparent slowness. Evidence may arrive late even when authorization is rapid. Authorization can be slow because standing is contested. Implementation can lag because capacity is scarce. Appeals may deliberately delay finality. A rule can also be intentionally sticky so that short-horizon fluctuations do not generate constant institutional change. These differences matter because a proposed remedy aimed at “speeding governance” may target the wrong stage.

Governance horizons can also be endogenous to economic conditions. Resource scarcity can lengthen inspection or adjudication. Concentrated expertise can shorten decision time for some actors while increasing dependence on those actors. Automation can accelerate monitoring while leaving interpretation and accountability unresolved. Economic analysis can identify these conditions without settling whether a shorter horizon is legitimate.

Proposition 23.160 (Governance-horizon decomposition). *A claim about governance speed should identify the response stage to which the claim refers, because detection, interpretation, authorization, implementation, feedback, and revision can possess different characteristic horizons and can respond differently to institutional change.*

23.7.3 Temporal Mismatch

A temporal mismatch arises when the relative response horizons of economically coupled processes become material to an outcome of interest. The direction of the mismatch matters. Governance may react more slowly than the economic process it seeks to influence; it may also react more quickly than the slower social or institutional relations that bear the consequences. Both cases can produce problems, and neither is captured adequately by a general presumption that faster governance is preferable.

Definition 23.161 (Directed response-horizon mismatch). Let $\tau_p(t) > 0$ denote the characteristic response horizon of an economic process p , and let $\gamma_g(t) > 0$ denote the characteristic response horizon of a governing process g . The *directed response-horizon mismatch* is defined by Equation 23.5.

$$m_{pg}(t) = \log\left(\frac{\gamma_g(t)}{\tau_p(t)}\right). \quad (23.5)$$

A positive value of $m_{pg}(t)$ indicates that the selected governing response horizon is longer than the selected economic-process horizon; a negative value indicates that governance responds on the shorter horizon; and a value near zero indicates similar characteristic horizons. Equation 23.5 is meaningful only when both horizons are independently justified and comparable for the task. It is not a welfare index, a legitimacy score, or a recommendation to equalize response times.

Definition 23.162 (Temporal-mismatch consequence profile). A *temporal-mismatch consequence profile* records the process pair, direction and magnitude of mismatch, lag structure, affected positions, economic consequences, adaptation strategies, option losses or gains, distribution of exposure, evidence of persistence, alternative explanations, and the governance questions that remain unresolved after the economic diagnosis.

Consequences can include regulatory arbitrage, delayed repair, accumulated exposure, unstable investment expectations, premature intervention, compliance churn, loss of institutional memory, or option foreclosure. The same numerical mismatch can have different implications across domains. A slow approval process can be costly in emergency response and protective in irreversible infrastructure decisions. An economic diagnosis therefore requires a mechanism linking timing to consequence.

Proposition 23.163 (Temporal-mismatch relevance condition). A *difference in characteristic response horizons becomes economically relevant when a reconstructable mechanism connects that difference to material changes in allocation, capability, dependence, value conversion or circulation, exposure, option structure, investment, maintenance, or another economically specified outcome.*

23.7.4 Cross-Frequency Coupling

Processes at different characteristic frequencies can remain strongly coupled. High-frequency market adjustment may accumulate into slower balance-sheet or employment effects. Slow institutional rules can shape the feasible set within which rapid transactions occur. Periodic reporting can trigger clustered behavior in processes that otherwise change continuously. The relevant research object is therefore the pathway through which one temporal band enters another, including lags, aggregation, thresholds, and feedback.

Definition 23.164 (Cross-frequency governance coupling). A *cross-frequency governance coupling* is a research-specified pathway through which variation in an economic or governing process represented at one characteristic rate materially affects a process represented at another rate, with the translation, aggregation, lag, threshold, or memory mechanism made explicit.

The delayed cross-scale coupling representation in Equation 23.1 supplies one possible formal template. At the governance interface, however, the map from one rate band to another must also identify institutional mediation. A rapid market signal may matter to a regulator only after it crosses a reporting threshold. A slow legal or organizational commitment may influence high-frequency behavior through constraints embedded in software, contracts, or access rules. Cross-frequency coupling

is therefore partly a question of information architecture and partly a question of institutional structure.

Definition 23.165 (Cross-frequency coupling dossier). *A cross-frequency coupling dossier records the source and receiving processes, characteristic rates, mediation mechanism, lag or memory structure, aggregation rule, thresholds, institutional interfaces, direction of influence, feedback, affected positions, evidence, competing mechanisms, and the historical regimes in which the coupling is expected to remain stable.*

Proposition 23.166 (Cross-frequency attribution discipline). *Observed correlation across processes with different characteristic rates supports a cross-frequency governance claim only when the research design identifies a plausible translation or transmission pathway and addresses relevant common causes, measurement aggregation, and institutional timing.*

23.7.5 Synchronization

Synchronization refers here to task-relative temporal alignment among processes, not to a universal objective of making institutions move at the same speed as markets. A governing process is synchronized with an economic process when their timing relation is adequate for a specified governing function under stated conditions. Adequacy can involve prompt response, deliberate delay, periodic review, buffering, or staged commitment.

Definition 23.167 (Governance synchronization profile). *A governance synchronization profile specifies the governing function, economic process, relevant response horizons, tolerated lag or lead, triggering conditions, buffering mechanisms, review cadence, affected positions, performance criteria, and evidence supporting the claim that the timing relation is adequate for that function.*

This definition makes synchronization functional rather than merely temporal. A circuit breaker may need to respond within minutes to a market discontinuity, while a pension-governance rule may intentionally resist high-frequency repricing. A scientific funding institution may need slow review for epistemic quality but faster emergency mechanisms for sudden infrastructure failure. The desirable temporal relation therefore depends on the object being governed and on values or authority questions that may exceed GRE.

Synchronization can also generate costs. Matching governance too closely to high-frequency signals can increase institutional volatility, short-horizon incentives, or sensitivity to noise. Conversely, periodic synchronization can create bunching, deadline effects, and synchronized risk-taking. GRE can investigate these economic consequences; GRG must evaluate when alignment is institutionally or normatively justified.

Proposition 23.168 (Task-relative synchronization). *Governance synchronization should be evaluated relative to a specified governing function and consequence structure; temporal alignment that improves one function can impair another and therefore does not constitute a general criterion of good governance.*

23.7.6 Desynchronization

Desynchronization occurs when the temporal relation among coupled processes no longer supports the function for which the relation was relied upon. The phenomenon can take several forms: persistent lag, premature intervention, missed decision windows, oscillatory correction, accumulated backlog, stale information, or asynchronous adaptation across institutions. Desynchronization can be episodic or structural.

Definition 23.169 (Governance desynchronization record). A *governance desynchronization record* documents the governing function that has become temporally misaligned, the economic and governing response horizons, the observed form of lag or lead, onset and persistence, affected positions, consequences, attempted adaptations, evidence of feedback or oscillation, and alternative explanations for the observed failure.

Desynchronization should not be diagnosed solely from dissatisfaction with an outcome. A regulator can act after a market movement without being desynchronized if delayed intervention is part of the governing design. Conversely, nominally rapid action can remain desynchronized when evidence collection, implementation, appeal, or repair operates on a much slower horizon than the public decision announcement suggests.

An important economic consequence is strategic adaptation. When actors learn that governance reacts with a predictable lag, they may shift behavior into the interval between economic change and institutional response. When governance reacts predictably to short-horizon indicators, actors can also optimize toward the trigger. These feedbacks can transform the temporal structure itself.

Proposition 23.170 (Endogenous desynchronization). A *governance timing mismatch can become endogenous when actors adapt strategically to the governing response horizon, thereby changing the economic process that the governance arrangement was calibrated to address.*

This proposition gives the interface a dynamic character. Temporal mismatch is not necessarily an externally given gap between two fixed clocks. Governance response can alter economic frequency, and economic adaptation can alter the effective governance horizon.

23.7.7 Institutional Response Times

Institutional response time is produced by a chain of processes rather than by one clock. Detection, interpretation, standing, authorization, implementation, enforcement, feedback, appeal, and revision can be sequential, overlapping, or distributed among institutions. Bottlenecks can migrate as one stage is accelerated. Faster data collection, for example, may simply move delay into interpretation or authorization.

Definition 23.171 (Institutional response-time vector). For a specified governing process g , an *institutional response-time vector* is an ordered collection of research-defined characteristic durations for the material stages of response, such as detection, interpretation, authorization, implementation, feedback, appeal, and revision, together with the dependency structure indicating which stages are sequential, parallel, conditional, or recurrent.

The vector is preferable to a single average response time when the institutional

mechanism matters. Two institutions can have the same total elapsed time while differing radically in where delay occurs and whose participation is possible during that delay. A long authorization stage can reflect legal safeguards; a long implementation stage can reflect capacity shortage; a long feedback stage can reflect poor observability. These cases create different economic consequences and different governance questions.

Definition 23.172 (Response-time bottleneck profile). A *response-time bottleneck profile* identifies the stages that materially determine the effective response horizon, the resources and authority controlling those stages, queueing or information constraints, distribution of waiting costs, opportunities for parallelization or delegation, and the safeguards that would be altered by acceleration.

Proposition 23.173 (Response-time bottleneck specificity). A *proposal to accelerate institutional response has adequate economic specificity only when it identifies which response stage is binding, how acceleration changes economic consequences, and which costs, safeguards, or participation opportunities may be displaced to another stage or position.*

The proposition does not determine whether acceleration is legitimate. It establishes what an economic argument must make visible before the question is handed to GRG.

23.7.8 Economic Questions

The frequency-domain interface generates questions that remain properly economic: how relative timing changes prices, investment, labor adjustment, maintenance, compliance costs, dependence, access, distribution, value pathways, capabilities, and option sets; who bears waiting costs; and who possesses the resources to bridge institutional lag.

Definition 23.174 (Economic timing question). An *economic timing question* asks how relative timing changes economically specified structures, mechanisms, distributions, capabilities, dependencies, value pathways, option sets, costs, exposures, or trajectories while leaving governance legitimacy to the appropriate domain.

Distributional, capability, relational, generative, value-circulation, and historical questions can therefore be distinguished according to the economic object altered by timing. Their comparison can be preserved in a common portfolio.

Definition 23.175 (Frequency-governance economic consequence portfolio). A *frequency-governance economic consequence portfolio* is a versioned collection of mismatch, coupling, synchronization, desynchronization, response-bottleneck, incidence, capability, option, and historical rate-regime records maintained across cases.

The portfolio supports comparison without presuming an optimal governance frequency. Recurrent patterns can generate stronger interface hypotheses while remaining short of governance prescriptions.

Proposition 23.176 (Economic frequency-domain answerability). A *frequency-domain claim remains within GRE when its warrant can be stated in terms of economically specified timing, mechanism, incidence, capability, dependence, value pathway, option structure, or consequence, with the response-horizon assumptions and historical regime made explicit.*

23.7.9 Questions Deferred to GRG

The disciplinary boundary is reached when the unresolved issue concerns the legitimate temporal constitution of governance itself: emergency authority, deliberative delay, fast-track triggers, standing in time-sensitive review, procedural safeguards, appeals under irreversibility, or the distribution of authority among institutions with different response horizons.

Definition 23.177 (Frequency-domain GRG handoff). A *frequency-domain GRG handoff* records an economically identified temporal problem and the unresolved governance premises concerning authority, legitimacy, standing, procedural cadence, review, emergency action, accountability, or constitutional ordering that must be supplied before a prescriptive governance conclusion is warranted.

Acceleration and delay can each redistribute power. Compressed consultation can privilege actors able to respond quickly; rapid compliance can favor organizations with greater administrative capacity; delayed action can impose irreversible exposure on positions with little ability to wait. GRE can reconstruct these economic asymmetries, while the legitimate procedural response requires governance-specific justification. The same applies to institutional slowing: cooling-off periods or longer commitment horizons can have economic merits while changing representation, accountability, and relations among governing bodies.

Definition 23.178 (GRG temporal-correction return). A *GRG temporal-correction return* records a governance finding that changes the economic interpretation of a response horizon, mismatch, synchronization claim, or institutional timing mechanism, including cases in which delay is constitutive of legitimate procedure, acceleration undermines standing or accountability, or the relevant governing unit differs from that assumed by GRE.

Definition 23.179 (Frequency-domain governance interface portfolio). A *frequency-domain governance interface portfolio* is a versioned collection of dynamical-frequency and governance-horizon profiles, mismatch and coupling dossiers, synchronization and desynchronization records, institutional response-time analyses, economic consequence portfolios, GRG handoffs, and temporal-correction returns maintained across cases and historical regimes.

Proposition 23.180 (Frequency-domain governance interface answerability). A *frequency-domain governance claim is cross-domain answerable when the characteristic horizons, comparison scale, coupling mechanism, economic consequence, governance-specific remainder, and possible GRG correction return are explicit enough that contrary evidence or governance analysis can revise the timing diagnosis, narrow the economic inference, or reclassify the question.*

The interface converts temporal-rate differences into bounded research questions rather than direct policy rules. GRE diagnoses economic consequences; GRG supplies the warrant where conclusions depend on legitimate authority, procedural cadence, standing, accountability, or constitutional design. The next section applies the same containment discipline to law.

23.8 Generative Relational Law Interface

Sections 23.6 and 23.7 established the governance interface and its temporal specialization. The present section turns to Generative Relational Law (GR-Law). Its role is to distinguish legally constituted positions from economically manifested relations while preserving the ways in which law can create, stabilize, authorize, constrain, revise, and sometimes transform economic possibility. The objective is not to reconstruct jurisprudence inside GRE. It is to specify how property, contract, legal personhood, rights, duties, recognition, legal infrastructure, and relational justice enter economic analysis; which parts of those objects remain specifically juridical; and how legal findings can return corrections to GRE. The section therefore develops nine interfaces: property, contract, legal personhood, rights, duties, institutional recognition, legal infrastructure, relational justice, and the limits of economic reduction. The method follows the containment and translation disciplines developed in Sections 23.2–23.3. Earlier GRE analyses of ownership and control, legal generative-field protection, and practical legal standing remain available as economic and governance architectures, while claims about legal validity, legal status, doctrinal interpretation, competent authority, or juridical consequence are handed to GR-Law for independent warrant.

Definition 23.181 (GRE–GR-Law interface record). A *GRE–GR-Law interface record* specifies an economically consequential legal configuration, the legal positions or institutions involved, the GRE objects affected, the direction of translation, the legal questions requiring independent analysis, the economic manifestations being investigated, temporal and jurisdictional boundaries, practical realization pathways, unresolved normative or doctrinal questions, expected legal correction returns, and the GRE claims that would require revision if the legal characterization changes.

The record prevents two opposite reductions. The first treats law as a surface description of underlying economic control, bargaining power, or material dependence. The second infers economic capability or practical consequence directly from formal legal status. GRE needs neither reduction. Legal forms can be causally constitutive of economic relations, while their practical incidence depends on resources, institutions, interpretation, enforcement, documentation, standing, and historical context. Earlier GRE work on law as generative-field protection showed that legal ordering can constitute and protect generative fields; the present task is to specify how such legal objects travel across the disciplinary boundary.

Proposition 23.182 (Legal handoff condition). A *GRE inquiry should hand a material subquestion to GR-Law when resolution of that subquestion depends principally on legal validity, legal classification, legal personhood, juridical standing, interpretation of authoritative legal materials, the existence or content of a right or duty, competent legal authority, or the legal consequences of an institutional act rather than on economic structure, mechanism, or consequence alone.*

Proposition 23.182 does not remove legal institutions from economic inquiry. GRE can continue to examine how a legally recognized position changes access, bargaining, dependency, investment, risk, value circulation, capability, or future options. The handoff concerns the source of warrant for the legal proposition. A legal conclusion should not be reconstructed indirectly from prices, incentives, social practice, or economic usefulness where the legal domain supplies its own criteria of recognition and validity.

Table 23.8: Principal operations at the GRE–GR–Law interface

Interface object	GRE contribution	GR–Law question	Return to GRE
Property	Control, access, use, exclusion, transfer, dependence, generative effect	Which legal positions constitute the property relation and under what authority?	Revised distinction between legal entitlement and economic control
Contract	Bargaining structure, dependence, allocation, incentives, performance consequences	Is an agreement legally valid, enforceable, interpretable, voidable, or otherwise legally qualified?	Revised account of feasible relations, remedies, and economic exposure
Legal personhood	Economic agency, organizational capacity, relational participation	Which entity or configuration possesses legal personality, powers, liabilities, or standing?	Revised subject boundaries and responsibility architecture
Rights	Effective access, capability, dependency, realization cost	What legal right exists, with which correlative positions and remedies?	Revised distinction between formal entitlement and practical capability
Duties	Compliance cost, burden incidence, maintenance, organizational capacity	What legal obligation exists, who bears it, and how is performance legally assessed?	Revised responsibility and incidence mapping
Recognition	Economic consequence of status, classification, registration, or authorization	Which act or institution creates, confirms, or contests legal status?	Revised boundary, membership, and access conditions
Legal infrastructure	Documentation, procedure, enforcement, remedy, institutional access	Which legal pathways and authorities make the position legally operable?	Revised realization, delay, exclusion, and correction pathways
Relational justice	Power, capability, dependence, participation, generative consequences	Which legal and normative standards bear on the relation, and which remain outside law?	Revised justice profile without collapsing validity into justice
Scope limit	Economic effects of legal ordering	Validity, doctrine, standing, interpretation, authority, legal remedy	Domain correction, reclassification, or narrowed GRE claim

Table 23.8 summarizes the principal operations developed below.

23.8.1 Property

Property is a particularly important interface because economic analysis frequently uses the language of ownership as if it were interchangeable with practical control. The earlier GRE analysis of ownership and control separated those positions within economic architecture. The legal interface requires a further distinction: legal property relations can allocate claims, powers, privileges, immunities, liabilities, use positions, exclusion positions, transfer powers, security interests, and remedial standing that do not map one-to-one onto observed control over a resource or asset.

Definition 23.183 (Property interface profile). A *property interface profile* records the economically relevant object, the legal property positions asserted or recognized, practical control and access, use and exclusion relations, transfer and succession possibilities, security or liability relations, jurisdiction and temporal scope, realization pathways, affected positions, and the economic consequences that depend on the distinction between legal entitlement and practical control.

This profile is useful where several actors possess different layers of authority over the same economically consequential object. A platform may control technical access while users retain contractual or statutory positions; a household may possess practical use of land while formal title remains elsewhere; a public body may own infrastructure whose operation is delegated; a community may possess socially recognized stewardship that only partly overlaps with formal legal property. GRE can reconstruct the economic incidence of these relations, but the legal content of title, possession, license, easement, security, or other legally differentiated positions re-

quires legal analysis.

Property can also create economic reality rather than merely record it. Legal title can enable collateralization, succession, exclusion, licensing, taxation, organizational separation, or legal remedy. These possibilities can alter investment, bargaining, mobility, risk, and generative capacity. Yet the economic consequence remains historically and institutionally mediated. A formally strong entitlement can be difficult to use, while a practically entrenched control relation can be economically powerful without corresponding legal title.

Proposition 23.184 (Property–control non-equivalence). *Neither legal property status nor observed economic control should be inferred from the other without an explicit interface analysis identifying the legal positions, realization pathways, practical control mechanisms, and domain-specific evidence that connect them.*

The proposition preserves both directions of correction. GR-Law can show that an apparent owner lacks a relevant legal power or that several distinct legal positions have been compressed into one economic variable. GRE can show that legally specified property relations produce uneven practical control because of finance, infrastructure, information, institutional access, or asymmetrical enforcement.

23.8.2 Contract

Contract connects legal relation formation with economic allocation, exchange, coordination, dependence, risk, and expectation. GRE can examine bargaining positions, outside options, information asymmetry, repeated interaction, switching cost, performance capacity, and downstream generativity. These economic features can strongly condition how a contractual arrangement operates. They do not, by themselves, establish whether a contract exists, how its terms are legally interpreted, whether particular provisions are enforceable, or which remedies follow from breach or invalidity.

Definition 23.185 (Contract interface record). *A contract interface record specifies the relevant parties or legal positions, the economically consequential agreement or purported agreement, bargaining and dependency conditions, exchanged performances or commitments, legal characterization requiring independent analysis, performance and enforcement pathways, remedies or termination possibilities where known, temporal scope, and the economic consequences that depend on the legal status or interpretation of the arrangement.*

The record separates three questions that are often collapsed. One concerns economic agreement: what positions expected to exchange or coordinate. A second concerns legal contract: whether the legal system recognizes a binding relation and with what content. A third concerns practical realization: what happens when performance, enforcement, renegotiation, or exit occurs in institutions with unequal resources and different response times. These questions interact without becoming identical.

Contract can also reorganize future possibility. Long commitments can stabilize investment and cooperation, but can constrain exit or redirect later bargaining. Standard-form contracts can reduce negotiation cost while centralizing rule formation. Automated or digitally mediated contracting can increase execution speed while shifting interpretation, correction, or contestation burdens. GRE can study these economic effects; GR-Law must determine the legal positions generated by the contractual architecture.

Proposition 23.186 (Contractual validity non-deduction). *Economic evidence concerning assent, exchange, efficiency, reliance, dependence, or performance cannot by itself establish contractual validity, legal interpretation, enforceability, or remedy; those propositions require legal warrant appropriate to the competent legal order.*

Conversely, legal validity does not settle the economic quality of the relation. A legally enforceable contract can coexist with severe dependency, capability asymmetry, extractive conversion, or weak practical exit. The interface therefore permits legal and economic assessments to remain simultaneously valid but analytically distinct.

23.8.3 Legal Personhood

Legal personhood is another point at which economic and legal vocabularies can diverge sharply. GRE can identify an organization, institution, community, platform, artificial system, or other stabilized configuration as an economically consequential relational entity. That economic entity need not possess legal personality. Conversely, a legal person can persist despite substantial changes in membership, assets, management, or economic capacity because the legal order supplies continuity rules that differ from the criteria used for economic identity.

Definition 23.187 (Legal-personhood interface profile). *A legal-personhood interface profile records the economically identified entity or configuration, the asserted or recognized legal person, the legal capacities or liabilities relevant to the case, continuity and representation rules, organizational or relational structures through which the person acts, practical control positions, affected counterparties, and the economic claims that depend on whether legal and economic entity boundaries coincide.*

This profile matters for responsibility, contracting, asset holding, litigation, taxation, succession, and institutional memory. Economic analysis can mistakenly attribute conduct to a diffuse network when law locates responsibility in a legally constituted organization; it can also overidentify the legal person with the practical site of decision when actual control lies elsewhere. The distinction becomes more important in complex corporate groups, platforms, public-private arrangements, autonomous technical systems, and other configurations in which legal personality, operational agency, control, and relational subjecthood are distributed differently.

Proposition 23.188 (Personhood non-equivalence). *Legal personhood, economic agency, organizational continuity, relational subjecthood, moral standing, and phenomenological subjectivity are distinct analytical statuses; a claim established at one level should not be transferred to another without an explicit translation and an independently adequate warrant.*

The proposition is particularly important for future GR work involving AI or non-human subjects. GRE may identify economically consequential agency or dependence without determining legal personhood. GR-Law may recognize legal personality for instrumental or institutional reasons without settling moral or ontological questions. The interface should preserve these remainders rather than force a unified concept of the subject.

23.8.4 Rights

Rights enter GRE through the economic possibilities and protections they condition. Access to property, employment, welfare, information, mobility, participation, privacy, remedy, or organizational decision can affect capability, bargaining, dependency, risk, and future options. Yet the word *right* should not be used as an economic shorthand for any desirable capability or protected interest. The earlier GRE treatment of legal generative-field protection already distinguished legal positions from broader practical effects; the present interface preserves that distinction across disciplines.

Definition 23.189 (Right-realization interface profile). *A right-realization interface profile records the legally specified right or legal position, its relevant correlatives, the competent legal source where identified, standing and procedural conditions, documentation requirements, enforcement and remedy pathways, time and resource costs, practical accessibility, affected economic capabilities, and the divergences between formal entitlement and realized economic possibility.*

A right can be economically consequential before litigation occurs because counterparties organize expectations around it. It can also remain weakly realized when evidence, procedure, representation, language, cost, delay, or institutional capacity obstruct use. This makes rights a relational infrastructure for economic possibility rather than a scalar resource that can simply be counted.

Proposition 23.190 (Formal-right capability divergence). *A legally recognized right and an economically realizable capability should be measured separately whenever exercise of the right depends on material, procedural, informational, organizational, or temporal conditions that vary across positions.*

The proposition does not demote formal recognition. Legal recognition can itself alter bargaining, expectation, remedy, or institutional obligation even before practical exercise. It instead prevents the economic researcher from treating recognition as sufficient evidence of effective capability or, conversely, from treating weak realization as evidence that no legal right exists.

23.8.5 Duties

Duties are the correlative side of many legally structured relations and can condition economic order through requirements to perform, refrain, disclose, maintain, compensate, care, protect, document, or cooperate. Their economic incidence depends on who bears the cost of compliance, what capability is required for performance, how duties are monitored, and what happens when responsibility is distributed across organizations or infrastructures.

Definition 23.191 (Duty-incidence profile). *A duty-incidence profile records the legally specified duty or asserted obligation, the position bearing it, beneficiaries or protected positions where identifiable, required conduct, compliance resources, monitoring and evidential conditions, performance pathway, sanctions or remedies where known, distribution of direct and indirect burdens, and the economic consequences of fulfillment, non-fulfillment, delegation, or transfer.*

Economic compliance cost is only one dimension. A duty can create organizational capability by requiring maintenance, reporting, preservation, or institutional learning. It can also shift burden toward smaller actors with less administrative capacity,

creating asymmetric exit or participation effects. Outsourcing performance can preserve formal responsibility while changing practical control and incidence. These are questions GRE can examine without deciding the legal content of the duty.

Proposition 23.192 (Duty-performance non-equivalence). *The legal existence of a duty, practical performance of the required conduct, economic incidence of compliance, and normative adequacy of the obligation are distinct propositions and should not be inferred from one another without the corresponding legal, empirical, and evaluative warrants.*

This distinction supports reciprocal correction. GR-Law can revise GRE when the economic model assigns responsibility to the wrong legal position or ignores legally non-delegable obligations. GRE can return evidence that nominal duty allocation produces persistent capacity bottlenecks, burden displacement, or weak realization.

23.8.6 Institutional Recognition

Many economic possibilities depend on institutional recognition: registration of a company, recognition of family status, licensing, citizenship or residency status, certification, title registration, insolvency status, legal capacity, protected classification, or recognition of an organization as competent to act. Recognition can therefore be constitutive rather than merely descriptive.

Definition 23.193 (Legal-recognition interface record). *A legal-recognition interface record identifies the status or position to be recognized, the competent institution or process, evidential and procedural requirements, effective date and duration, contestation or correction pathways, economic capacities activated or constrained by recognition, excluded or ambiguous positions, and the GRE claims that depend on the recognition decision.*

Recognition can alter boundaries and membership in ways that have immediate economic effects. An organization can acquire capacity to contract, hold assets, employ staff, or receive funding. A person can become eligible for welfare, work, mobility, inheritance, or representation. A resource can enter a protected category that changes use, transfer, or liability. These changes are not adequately modeled as shifts in preference or price because the legal act can constitute the relevant economic position itself.

Proposition 23.194 (Recognition constitutivity condition). *Where a legal recognition act creates or materially changes the status required for economically consequential action, GRE should model the recognition event as a constitutive change in the relevant relational architecture rather than as a mere informational update about a pre-existing economic state.*

The converse also matters. Not every social or economic recognition is legal recognition. Communities, platforms, markets, or professional fields can recognize statuses through non-legal processes. The interface record should therefore identify which recognition regime is doing the constitutive work.

23.8.7 Legal Infrastructure

Legal positions become economically usable through infrastructures of documentation, registration, advice, evidence, adjudication, administration, enforcement, ap-

peal, and remedy. The earlier GRE treatment of relational infrastructure located legal infrastructure among the systems that make formal standing practically consequential. The present interface asks which parts of that realization pathway remain economic objects and which require legal interpretation.

Definition 23.195 (Legal-infrastructure dependency profile). *A legal-infrastructure dependency profile* records the documents, registries, competent institutions, procedural stages, evidential systems, representation resources, enforcement mechanisms, remedies, digital or physical access points, interoperability dependencies, response times, and correction pathways required for a legal position to become practically consequential in an economic setting.

The profile can reveal single points of exclusion. A formal entitlement may depend on identity documentation, a registry entry, legal advice, a filing deadline, a digital credential, translation, or access to a competent tribunal. Delay at one stage can shift bargaining power elsewhere. A remedy that arrives after an irreversible economic loss can remain legally meaningful while providing limited restoration of the earlier option set. Infrastructure therefore connects legal time to economic time.

Legal infrastructure can itself become a field of power and dependence. Concentrated expertise, procedural complexity, proprietary digital systems, high representation costs, or asymmetrical access to evidence can shape whose legal positions become economically effective. GRE can analyze this incidence. The legal evaluation of procedure, due process, jurisdiction, admissibility, remedy, or institutional competence remains a GR-Law question.

Proposition 23.196 (Legal-infrastructure realization condition). *Where an economic capability, protection, or liability depends materially on legal status, the analysis should trace the institutional realization pathway and its costs, delays, failure modes, and remedies rather than infer practical economic standing from formal legal recognition alone.*

This proposition also makes infrastructure a correction channel. If GR-Law shows that GRE has assumed an unavailable remedy, misidentified the competent authority, or overlooked a procedural precondition, the economic model of access, risk, or bargaining should be revised.

23.8.8 Relational Justice

The interface with justice requires especially careful containment because legal validity, legal protection, economic relational justice, and broader normative justice are related but non-equivalent. The earlier GRE treatment of relational justice examined justice through the quality and conditions of relations. Legal institutions can protect standing, allocate remedies, constrain domination, structure participation, recognize responsibility, and make claims contestable. Yet neither legal compliance nor economic generativity is sufficient by itself to establish justice.

Definition 23.197 (Legal-relational justice interface). *A legal-relational justice interface* records the economically consequential relation under evaluation, affected positions and standing, relevant legal rights, duties, powers, liabilities, procedures, recognition structures, remedies, practical realization conditions, GRE justice considerations, unresolved normative premises, and the points at which legal validity and broader justice evaluation diverge.

The interface is needed because law can correct some relational injustices while

reproducing or legitimating others. A procedure may satisfy formal requirements yet remain economically inaccessible. A property arrangement may be legally stable while concentrating generative opportunity. A contract may be valid while practical exit is severely asymmetric. Conversely, a relation that appears economically unequal can be structured by legal protections that are invisible in a coarse economic representation. The legal domain can therefore change the relevant justice facts without exhausting the justice inquiry.

Proposition 23.198 (Validity–justice non-equivalence). *Legal validity, legality of conduct, effective legal protection, economic relational justice, and broader normative justice are distinct evaluative objects; a conclusion at one level should not be treated as sufficient warrant for a conclusion at another.*

A relational justice analysis should consequently record where its normative premises come from. GRE can identify dependence, asymmetry, exclusion, capability loss, generative foreclosure, or unequal participation as normatively relevant structures. GR-Law can identify legal rights, duties, standing, procedural guarantees, and remedies. Political theory, ethics, or other domains may still be required to justify broader claims about legitimacy, priority, or obligation. The interface keeps these contributions composable without forcing one domain to dominate the others.

23.8.9 Limits of Economic Reduction

The legal interface reaches its boundary when economic explanation begins to substitute for legal warrant. Law can have economic functions, but legal categories are not exhausted by their efficiency, incentive, distributional, or generative effects. Property is not merely control; contract is not merely exchange; personhood is not merely agency; rights are not merely capabilities; duties are not merely costs; recognition is not merely information; legal procedure is not merely transaction friction; and legal remedy is not merely compensation. Each category possesses domain-specific structure that can become economically consequential precisely because it is legally constituted.

Definition 23.199 (Economic-reduction signal in legal analysis). An *economic-reduction signal in legal analysis* is an analytical move that treats a materially legal question as resolved by economic variables or functions while omitting the legal criteria of validity, classification, authority, interpretation, standing, procedure, or remedy on which the legal proposition depends.

Common signals include equating de facto control with ownership, treating repeated performance as sufficient evidence of contractual validity, inferring legal personhood from operational autonomy, counting nominal rights as effective capabilities, treating legal duties only as compliance costs, describing registration as a passive information event, and evaluating procedure solely through speed or administrative expense. These moves can be useful simplifications for a bounded economic task, but they become invalid when the omitted legal structure is material to the conclusion.

Definition 23.200 (GR-Law correction return). A *GR-Law correction return* records a legal finding that requires revision of a GRE object, boundary, mechanism, subject classification, option set, responsibility allocation, temporal assumption, or economic consequence because the prior economic analysis mischaracterized or omitted a materially relevant legal relation.

Correction can move in several directions. GR-Law may show that a legally rec-

ognized power exists where GRE modeled only informal influence; that a purported property relation is legally divided among several positions; that an entity lacks legal capacity assumed by an economic model; that a right or duty is narrower or broader than the economic proxy; or that a remedy changes the effective option set. GRE can return evidence that legal rules operate through unexpected economic dependencies, generate unequal realization costs, or alter long-horizon generative conditions. Neither correction has automatic priority outside the proposition it supports.

Definition 23.201 (GRE–GR–Law interface portfolio). A *GRE–GR–Law interface portfolio* is a versioned collection of property, contract, personhood, rights, duties, recognition, infrastructure, justice, handoff, and correction records maintained across jurisdictions, institutions, historical periods, and economic domains.

The portfolio makes legal variation analytically visible. A legal form that produces one economic effect in one institutional environment may generate another elsewhere because enforcement, administrative capacity, social practice, or infrastructural access differs. Comparative work should therefore preserve jurisdiction, period, institutional setting, and doctrinal version rather than treating a legal label as a universally equivalent variable.

Proposition 23.202 (GRE–GR–Law interface answerability). A *GRE claim that materially depends on law is cross-domain answerable when the relevant legal object, source of legal warrant, economic manifestation, realization pathway, jurisdictional and temporal scope, domain-specific remainder, and possible GR–Law correction return are explicit enough that contrary legal analysis can revise the economic interpretation or reclassify the question.*

This condition keeps law economically consequential without making it economically reducible. GRE studies how legally constituted positions alter resources, relations, capabilities, dependence, value pathways, participation, and future options. GR–Law supplies the domain warrant where the conclusion depends on legal validity, classification, standing, interpretation, authority, or remedy. The next section carries the same containment discipline into political theory, where power, authority, legitimacy, participation, and collective action create another closely coupled but non-equivalent interface.

23.9 Political Theory Interface

Section 23.8 established the interface between GRE and Generative Relational Law by separating juridical constitution from economic manifestation. The present section turns to political theory. Its role is to identify where economic relations become inseparable from questions of political power, authority, collective action, public institutions, legitimacy, participation, recognition, and political-economic ordering without allowing GRE to absorb those questions into economics. The objective is to specify which political phenomena GRE can investigate as economically consequential structures, which propositions require specifically political-theoretical warrant, and how political-theoretical findings can return corrections to GRE. The section develops nine interfaces: power, authority, collective action, public institutions, legitimacy, participation, recognition, political economy, and the limits of economic explanation. The method follows the containment and translation disciplines established in Sections 23.2–23.3. Earlier GRE analyses of economic power, justice, governance, insti-

tutions, and public economic order remain available, but they do not independently establish political authority, public legitimacy, political standing, or the normative terms of collective rule.

Definition 23.203 (GRE–political-theory interface record). A *GRE–political-theory interface record* specifies an economically consequential political configuration, the relevant economic positions and relations, the political objects or claims involved, the direction of translation, the economic manifestations under investigation, the political-theoretical questions requiring independent warrant, the institutional and historical boundaries of the inquiry, the principal forms of evidence, unresolved normative questions, expected political-theory correction returns, and the GRE claims that would require revision if the political characterization changes.

The record is designed to prevent four recurrent collapses. Economic power should not be equated with political power. Effective control should not be equated with authority. Collective economic coordination should not be equated with political collective action. Economic performance or social acceptance should not be treated as sufficient evidence of political legitimacy. These distinctions remain compatible with strong causal interaction across the boundary. Resources, ownership, information, dependence, organization, infrastructure, and capability can condition political possibility, while political authority, institutional design, recognition, and collective decisions can restructure economic relations.

Proposition 23.204 (Political-theory handoff condition). A *GRE inquiry* should hand a material subquestion to political theory when resolution of that subquestion depends principally on political authority, legitimacy, collective standing, public justification, representation, membership in a political community, the normative structure of collective decision, or specifically political forms of recognition rather than on economic mechanism or consequence alone.

Proposition 23.204 concerns the source of warrant rather than the importance of the political object for economics. GRE can continue to analyze how authority, participation, recognition, or public institutions alter allocation, capability, bargaining, risk, value conversion, investment, dependence, or generative opportunity. The handoff is triggered when the conclusion itself is political-theoretical.

Table 23.9 summarizes the principal operations developed below.

23.9.1 Power

Power is the first interface because Chapter 16 already established an extensive GRE architecture for economic power. That architecture distinguishes asymmetry from relationally realized power and identifies mechanisms involving resources, capabilities, dependence, institutional position, conversion, circulation, capture, and reproduction. Political theory introduces an additional question: under what conditions does a power relation become specifically political rather than merely economically consequential?

Definition 23.205 (Political-power interface profile). A *political-power interface profile* records the relevant economic asymmetries, the affected positions, the collective or public relation in which power is exercised, the decision or possibility being conditioned, the mechanism of influence or control, the institutional setting, the relevant political standing or membership relation, the temporal horizon, contestability, and the economic consequences of the political power relation.

Table 23.9: Principal operations at the GRE–political-theory interface

Interface object	GRE contribution	Political-theory question	Return to GRE
Power	Resources, dependence, capability, conversion, circulation, control	When does an asymmetry become specifically political power, through which public or collective relation?	Revised power typing and mechanism boundaries
Authority	Compliance conditions, institutional capacity, economic incidence	What authorizes rule, decision, command, or representation?	Revised distinction between control, office, and authority
Collective action	Coordination costs, incentives, resources, network structure	What constitutes a political collectivity, public purpose, or representative action?	Revised collective unit and coordination mechanism
Public institutions	Fiscal capacity, allocation, administration, infrastructure	What makes an institution public and what political standing attaches to its acts?	Revised public/private and institutional boundary assumptions
Legitimacy	Economic conditions and consequences of acceptance, contestation, compliance	What makes an exercise of power or authority politically legitimate?	Revised treatment of compliance, durability, and institutional stability
Participation	Access costs, capabilities, material constraints, incidence	What counts as political participation, standing, representation, or voice?	Revised participation and exclusion profiles
Recognition	Economic consequences of status, membership, visibility, classification	What political status or standing is created, denied, or contested?	Revised subject, membership, and capability boundaries
Political economy	Mutual conditioning of economic and political structures	Which political mechanisms constitute, stabilize, or transform economic ordering?	Revised causal architecture and scope of economic explanation
Scope limit	Economic manifestations and consequences of political ordering	Authority, legitimacy, public justification, representation, political membership	Handoff, reclassification, or joint governance

This profile prevents political power from being inferred directly from wealth, ownership, market concentration, or organizational resources. These can be important carriers or enabling conditions, but the political claim requires an additional relational specification. Economic resources may finance agenda setting, organization, information production, lobbying, electoral mobilization, institutional access, or coercive capacity. Yet the political mechanism depends on how those resources enter institutions, public decisions, collective membership, authority structures, or recognized political channels.

Conversely, political power can reshape economic possibility without being reducible to prior economic advantage. Public authority may redefine property, taxation, eligibility, organizational form, labor regulation, monetary conditions, public investment, or legal status. GRE therefore needs a typed interface rather than a one-directional account in which economic resources mechanically become political outcomes.

Proposition 23.206 (Economic–political power non-equivalence). *Economic power and political power should be treated as non-equivalent typed relations unless an interface analysis identifies the collective or public mechanism through which an economic asymmetry becomes politically operative or a political power relation becomes economically consequential.*

The proposition allows strong coupling without identity. It also creates room for empirical divergence: concentrated economic resources may fail to translate into political influence under some institutional conditions, while politically authoritative positions may exercise substantial economic effects despite limited private wealth.

23.9.2 Authority

Authority requires a sharper boundary because observed compliance, organizational hierarchy, or practical control can be economically reconstructed without establishing why an actor or institution is entitled, authorized, or recognized to issue binding decisions. GRE can analyze the costs, capacities, incentives, dependencies, and consequences surrounding authoritative arrangements, but the specifically political meaning of authority requires a separate warrant.

Definition 23.207 (Authority–economy interface record). An *authority–economy interface record* specifies the actor or institution claiming or exercising authority, the domain of decision, the affected economic positions, the resources and administrative capacities supporting implementation, the observed patterns of compliance or contestation, the political basis of authority requiring independent analysis, and the economic consequences produced through the authoritative relation.

The distinction is useful where several mechanisms can generate similar behavior. An employer may obtain compliance through contractual dependence; a platform may structure action through technical control; a public agency may issue decisions backed by legal competence; a political institution may claim authority over a population; a community body may possess socially recognized leadership. Their economic effects may overlap, but their political status need not.

Proposition 23.208 (Authority non-deduction). *Political authority should not be inferred solely from effective control, repeated compliance, organizational hierarchy, economic indispensability, coercive capacity, or administrative success.*

The proposition also protects GRE from an inverse mistake. A politically authoritative institution may lack the economic resources or administrative capacity required to realize its decisions. GRE can investigate that implementation gap, but it should not redefine authority as whatever produces compliance most efficiently. Political theory remains responsible for the constitutive and normative question of authority, while GRE investigates the economic conditions and consequences of its exercise.

23.9.3 Collective Action

Collective action is closely connected to economic coordination, but the two are not interchangeable. GRE can study resource mobilization, coordination costs, incentive compatibility, network structure, shared infrastructures, dependence, and distributional consequences. Political collective action may additionally involve the constitution of a public, representation, contestation, common purposes, political identity, and claims made in the name of others.

Definition 23.209 (Collective-action interface profile). A *collective-action interface profile* records the participants and represented positions, the collective objective or contested issue, resource and coordination requirements, decision and representation procedures, participation and exit conditions, internal asymmetries, relevant public or political standing, external effects, temporal durability, and the economic consequences of collective action or collective-action failure.

This profile makes it possible to use economic theories of incentives or coordination without treating them as complete theories of political collectivity. Free-riding, transaction costs, organizational resources, or selective incentives may explain part of mobilization, but they do not alone establish who constitutes the collective, whose

interests can be represented, how dissent is handled, or why an action should count as politically representative.

Proposition 23.210 (Collective-action domain differentiation). *Economic coordination analysis can inform political collective-action research when resource, incentive, and dependency mechanisms are material, but political claims about collective standing, representation, membership, and public purpose require additional political-theoretical analysis.*

The interface is especially important for unions, associations, social movements, cooperatives, public campaigns, neighborhood organizations, and platform-mediated collectivities. GRE may analyze how material capacity enables participation or how collective action changes allocation and bargaining. Political theory may revise the unit of analysis when the relevant political collective differs from the economically convenient aggregation.

23.9.4 Public Institutions

Public institutions connect governance, law, economics, and political theory. GRE can analyze public finance, administrative capacity, service provision, procurement, infrastructure, redistribution, public investment, institutional learning, and the economic consequences of organizational design. The additional political question is what makes an institution public in the relevant sense and what authority, standing, accountability, or representative relation attaches to its acts.

Definition 23.211 (Public-institution interface record). *A public-institution interface record specifies the institution, its legally and politically constituted mandate, the public or constituency to which it is related, its resource base, decision architecture, administrative capabilities, accountability and contestation channels, affected economic positions, and the economic consequences of its decisions and institutional capacities.*

The record guards against defining publicness by funding source or ownership alone. A publicly funded organization may exercise little political authority; a privately organized body may perform delegated public functions; hybrid institutions may combine public mandate with market financing; central banks, universities, utilities, public corporations, regulatory bodies, and multilevel institutions can occupy different positions across jurisdictions.

Proposition 23.212 (Publicness non-deduction). *The political publicness of an institution should not be inferred solely from public funding, state ownership, administrative scale, monopoly position, economic importance, or service provision.*

GRE can nonetheless study the consequences of public institutional form. Fiscal capacity, staffing, informational infrastructure, procurement rules, bureaucratic delay, risk-bearing capacity, and institutional memory can shape economic generativity. Political theory remains necessary where the analysis turns to representative standing, public authority, political accountability, or the justification of collective institutional power.

23.9.5 Legitimacy

Legitimacy marks one of the clearest limits on economic reduction. Institutions with high output, low administrative cost, rapid response, stable compliance, or broad material benefits may still face political-theoretical questions about legitimacy. Conversely, a politically legitimate institution may produce costly, contested, or economically inefficient outcomes under some conditions. GRE therefore needs an interface that allows economic evidence to matter without allowing economic performance to settle the political question.

Definition 23.213 (Legitimacy–economy interface profile). A *legitimacy–economy interface profile* records the institution or exercise of power under evaluation, the affected political community or positions, the economic conditions supporting or constraining the arrangement, observed compliance and contestation, distributional and generative consequences, material participation conditions, the political standards of legitimacy requiring independent argument, and the economic consequences of legitimacy or legitimacy deficits.

Economic inquiry can contribute in at least three ways. First, it can show whether participation, voice, legal remedy, or public reasoning is materially inaccessible to some groups. Second, it can identify who bears the costs of maintaining an institution and who receives its benefits. Third, it can examine whether economic dependence makes apparent consent or compliance difficult to interpret. These findings can be politically relevant without themselves constituting a theory of legitimacy.

A further interface problem appears when a contract-like mode of public justification is retained across heterogeneous subjects or communities that do not begin with a fully shared normative grammar. One possible GR research construction treats mediation as historically generated rather than presupposed. Repeated translation, recognition, restriction of admissible terms, and institutional stabilization can produce a bounded mediator nomos within which some contract-formative interaction becomes locally coherent. GRE can investigate the material conditions, asymmetries, infrastructures, and capability effects of that mediation, while political theory and law retain responsibility for whether the resulting justificatory or legal relation is normatively or juridically adequate.

The important scope condition is local sufficiency. A mediated corridor can support a particular agreement, institutional interface, or domain of public reasoning while substantial untranslated remainders persist outside that corridor. Local coherence therefore does not establish that the participating nomoi are globally equivalent, that all reasons translate, or that the mediator supplies a universally shared normative order.

Proposition 23.214 (Local mediation without global nomic equivalence). *The existence of a sufficiently coherent mediated domain for a bounded contract-like or justificatory interaction does not by itself establish global equivalence among the participating normative orders; the scope, untranslated remainders, formation history, and conditions of continued mediation remain part of the political-theoretical interface.*

Proposition 23.215 (Performance–legitimacy non-equivalence). *Economic performance, aggregate welfare gains, administrative efficiency, institutional durability, observed compliance, or low contestation should not be treated as sufficient evidence of political legitimacy.*

The reverse also matters. Political legitimacy does not imply that economic con-

sequences are benign, equally distributed, or generatively sustainable. The two domains therefore require reciprocal correction rather than hierarchical reduction.

23.9.6 Participation

Participation already appears throughout GRE in economic relations, organizational life, governance, knowledge production, and AI-mediated systems. Political participation introduces additional issues of standing, representation, voice, agenda influence, membership, and collective decision. A person can participate economically while being excluded politically, or possess formal political participation rights while lacking the resources, time, information, accessibility, or security needed for effective exercise.

Definition 23.216 (Political-participation interface profile). *A political-participation interface profile records formal opportunities for political participation, effective access conditions, resource and capability requirements, standing and membership rules, agenda and decision channels, representation structures, participation burdens, participation-induced risks, internal asymmetries, and the economic consequences of participation or exclusion.*

The profile allows GRE to investigate material participation conditions while leaving the specifically political meaning of participation to political theory. Time scarcity, transport, care obligations, income loss, information costs, digital access, language capacity, disability accommodation, and exposure to retaliation can all affect practical participation. They are economically tractable without defining what participation should count as politically sufficient.

Proposition 23.217 (Formal–effective political participation distinction). *Formal availability of a participatory channel should be distinguished from effective political participation when access costs, capability requirements, standing rules, representation structures, or material risks generate systematic differences in who can use the channel and with what influence.*

GRE can therefore contribute a participation-incidence analysis, but political theory must still address questions concerning representation, equality of political standing, deliberative adequacy, or the normative meaning of voice.

23.9.7 Recognition

Recognition is another concept shared across domains but not automatically equivalent. Economic institutions recognize categories for purposes such as eligibility, credit, employment, pricing, ownership, membership, or access. Political recognition may concern membership in a polity, public status, minority standing, representation, visibility, or acknowledgement of historically constituted groups. These forms can interact without collapsing into one another.

Definition 23.218 (Political-recognition interface record). *A political-recognition interface record specifies the subject or group seeking or receiving recognition, the political status or standing at issue, the recognizing institution or public, the economic classifications that interact with the political status, material conditions of recognition, exclusion or misrecognition pathways, and the economic consequences of recognition, non-recognition, or contested recognition.*

Recognition can be constitutive. A status may alter access to representation, public resources, legal remedies, institutional consultation, or eligibility for specific protections. Yet GRE should not infer political recognition from economic inclusion alone. Market access, employment, taxation, or service eligibility may coexist with political exclusion or unequal standing.

Proposition 23.219 (Recognition non-equivalence). *Economic recognition, institutional classification, legal recognition, social visibility, and political recognition should be treated as distinct but potentially interacting relations unless the inquiry supplies an explicit translation establishing the relevant correspondence.*

The proposition is particularly important for analyses of marginalized groups, migrants, indigenous communities, informal workers, stateless persons, algorithmically classified populations, and other positions whose economic and political recognition can diverge substantially.

23.9.8 Political Economy Interface

Political economy is not merely the juxtaposition of political and economic variables. It concerns configurations in which political and economic structures are mutually conditioning and sometimes jointly constitutive. Chapter 21 already placed GRE in dialogue with political-economic traditions. The present task is narrower: to define the interface through which political-theoretical claims and GRE claims can interact without either domain claiming exhaustive explanatory priority.

Definition 23.220 (Political-economy interface dossier). *A political-economy interface dossier records the economic structures under investigation, the political institutions and relations conditioning them, the direction and timing of causal or constitutive influence, the relevant power and authority mechanisms, historical dependencies, public decisions, distributive and generative consequences, competing economic and political explanations, and the points at which domain-specific warrant is required.*

The dossier should distinguish at least four patterns. Economic structures can condition political organization by shaping resources, dependencies, concentration, or participation costs. Political institutions can condition economic structures through taxation, monetary arrangements, property regimes, public investment, regulation, recognition, and institutional design. Some arrangements may be jointly constituted, so separating a political cause from an economic effect becomes analytically misleading. Finally, the domains can change at different rates, producing lags and feedbacks rather than a stable one-way relation.

Proposition 23.221 (Bidirectional political-economic constitution). *Where evidence supports reciprocal or jointly constitutive mechanisms, GRE should represent political and economic structures as bidirectionally conditioning rather than assigning explanatory priority to one domain by default.*

This proposition does not imply symmetrical influence in every case. The direction, strength, timing, and scale of influence remain empirical and historical questions. It instead rejects a default hierarchy in which economic structure is always foundational or political institutions are always decisive.

Definition 23.222 (Political-theory correction return). *A political-theory correction return is a documented finding from political-theoretical inquiry that requires GRE to revise an economic object, relation, mechanism, subject boundary, institutional*

classification, participation profile, power type, public/private distinction, or scope claim because the prior GRE formulation depended on an inadequate political characterization.

Examples include discovering that GRE treated an exercise of authority as mere organizational control, modeled a constituency as a homogeneous economic group despite contested political membership, inferred legitimacy from compliance, or treated a public institution as equivalent to a large service provider. Such corrections belong inside the GRE research record rather than being relegated to external commentary.

23.9.9 Limits of Economic Explanation

The political-theory interface becomes most important where economic mechanisms remain relevant but cease to be sufficient for the principal claim. Political questions often include economic conditions and consequences; that does not make them reducible to economic explanation. The relevant boundary is therefore substantive rather than lexical.

Definition 23.223 (Economic-reduction signal in political analysis). An *economic-reduction signal in political analysis* is present when a political claim concerning authority, legitimacy, political standing, representation, public justification, collective membership, or recognition is inferred principally from economic performance, resource possession, incentives, market behavior, observed compliance, or aggregate welfare without an independently warranted political bridge.

The signal does not make economic evidence irrelevant. It identifies a missing interface step. An institution's distributive consequences can be central to legitimacy arguments, but those consequences do not constitute the entire legitimacy claim. Economic dependence can distort participation, but measuring dependence does not establish what equal political standing requires. Concentrated wealth can condition political power, but wealth concentration is not itself a complete political-power relation.

Proposition 23.224 (Political explanation handoff). *When the principal explanatory or evaluative burden of an inquiry depends on specifically political concepts whose content cannot be supplied by economic relations alone, the inquiry should move to political theory, adopt joint GRE-political-theory governance, or narrow its GRE claim to the economic conditions and consequences that GRE can warrant.*

A disciplined interface also requires return paths. Political theory can reveal that an economic unit has been politically misclassified, that a participation variable conceals unequal standing, that an authority relation has been mistaken for control, or that economic welfare has been used as a proxy for legitimacy. GRE can return complementary evidence concerning material barriers, capability effects, dependence, distribution, long-horizon economic consequences, and generative opportunity.

Definition 23.225 (GRE-political-theory interface portfolio). A *GRE-political-theory interface portfolio* is a versioned collection of political-interface records, power translations, authority handoffs, collective-action profiles, public-institution records, legitimacy interfaces, participation profiles, recognition interfaces, political-economy dossiers, correction returns, non-equivalent concepts, and unresolved boundary questions maintained across projects.

The portfolio makes repeated interface problems visible. It can show, for exam-

ple, whether GRE repeatedly overextends economic power into political authority, whether participation studies systematically omit political standing, or whether public-institution analyses compress heterogeneous political mandates into administrative capacity variables.

Proposition 23.226 (GRE–political-theory interface answerability). *A GRE–political-theory interface is answerable when the economic claim, political claim, translation path, evidential source, domain-specific remainder, and possible political-theory correction return are explicit enough that contrary political analysis can revise the GRE interpretation or reclassify the inquiry.*

This condition preserves a productive but bounded political interface. GRE can investigate how economic structure conditions political possibility and how political ordering reshapes economic relations. Political theory retains independent responsibility for authority, legitimacy, representation, political standing, collective membership, and public justification. Their interaction becomes a site of reciprocal correction rather than a route toward disciplinary absorption.

23.10 Generative Relational Education Interface

Chapter 19 treated education as a substantive economic domain in which resources, institutions, infrastructures, technologies, and relations participate in the generation of learning, capability, judgment, participation, and future options. The present section has a different role. It specifies the interface between GRE and a prospective Generative Relational Education programme without turning GRE into a general theory of education. Its objective is to identify which educational structures GRE can investigate through economic conditions and consequences, which claims require specifically educational or pedagogical warrant, and how educational findings can return corrections to GRE. The section develops nine interfaces: learning relations, capability generation, curiosity, aesthetic judgment, epistemic participation, educational infrastructure, knowledge communities, economic conditions of education, and limits of economic reduction. The method follows the containment and translation disciplines established in Sections 23.2–23.3. The educational domain analysis developed in Chapter 19 remains available, but its economic description does not by itself establish educational quality, pedagogical adequacy, developmental appropriateness, or the purposes that education ought to serve.

Definition 23.227 (GRE–education interface record). *A GRE–education interface record specifies the learner or learning collective, the educational relation or process under investigation, the relevant economic positions and constraints, the educational objects or claims involved, the economic manifestations being studied, the educational-theoretical questions requiring independent warrant, the temporal and developmental horizon, the infrastructures and communities supporting learning, the principal forms of evidence, and the GRE claims that would require revision if the educational characterization changes.*

The record separates three questions that often travel together but should remain analytically distinct. First, under what economic conditions can learning relations occur? Second, what educational processes actually generate learning, capability, curiosity, judgment, or participation? Third, what later economic consequences follow from those educational changes? GRE has a direct role in the first and third ques-

Table 23.10: Principal operations at the GRE–education interface

Interface object	GRE contribution	Educational-theory question	Return to GRE
Learning relations	Time, resources, access, dependency, institutional and technological conditions	Which relations support learning, feedback, practice, recognition, and development?	Revised conversion and relation architecture
Capability generation	Resource conversion, option expansion, durability, economic realization	Which capabilities are educationally constituted and how are they regenerated?	Revised distinction between output and capability
Curiosity	Security, time, exposure, access, attention, opportunity cost	How is curiosity cultivated, sustained, redirected, or weakened?	Revised treatment of preference, salience, and question formation
Aesthetic judgment	Abundance, selection constraints, informational environments	How is educational judgment formed and calibrated within a field of practice?	Revised orientation and judgment variables
Epistemic participation	Access, standing costs, language, infrastructure, network position	What counts as consequential participation in learning and knowledge practice?	Revised participation and capability profiles
Educational infrastructure	Funding, labor, facilities, platforms, accessibility, maintenance	Which infrastructures are pedagogically usable and developmentally appropriate?	Revised access, maintenance, and resilience analysis
Knowledge communities	Resource flows, mentoring capacity, reproduction, entry conditions	How are norms, practices, identities, and standards learned through participation?	Revised unit of analysis and community-reproduction mechanisms
Economic conditions	Distribution, household constraints, public finance, labor markets, opportunity costs	How do educational aims respond to or resist economic pressures?	Revised incidence and generative-return claims
Scope limit	Economic conditions and consequences of education	Educational quality, pedagogy, development, curricular purpose, formation of judgment	Handoff, reclassification, or joint inquiry

tions and a bounded role in the second. Educational theory, pedagogy, developmental inquiry, and domain-specific teaching knowledge can be constitutive to the second question even when the process is economically consequential.

Proposition 23.228 (Educational-theory handoff condition). *A GRE inquiry should hand a material subquestion to educational theory when resolution of that subquestion depends principally on the constitution of learning, pedagogical adequacy, developmental appropriateness, curricular purpose, educational relationship, or the formation of educational judgment rather than on economic condition or consequence alone.*

Proposition 23.228 does not make educational processes external to economic inquiry. Time, household security, teacher labor, institutional funding, language access, digital infrastructure, credential systems, geographic location, disability access, and opportunity costs can materially determine which educational relations are reachable and sustainable. The handoff concerns the source of warrant for the educational claim.

Table 23.10 summarizes the principal operations developed below.

23.10.1 Learning Relations

Learning relations are the first interface because Chapter 19 already represented education as historically situated interaction among learners, teachers, peers, texts, tools, families, institutions, communities, and artificial systems. The interface question is narrower: which properties of these relations are economically conditioned, and which require educational interpretation before GRE can treat them as generative?

Definition 23.229 (Learning-relation interface profile). *A learning-relation interface profile records the learner or learning collective, the persons, practices, artifacts, insti-*

tutions, or systems participating in the relation, the economic conditions enabling or constraining contact, the forms of instruction, participation, feedback, recognition, and practice involved, the expected educational change, the temporal horizon, evidence of later capability or participation, and the educational questions that cannot be settled by economic observables alone.

The profile prevents resource provision from standing in for an educational relation. A funded classroom, tutoring subscription, network connection, AI tutor, or teacher allocation can make interaction possible without establishing that the interaction produces understanding, revisable capability, or a sustainable learning trajectory. Conversely, a relation can be educationally powerful even when the material resource intensity is modest, provided that it supplies appropriate challenge, feedback, participation, trust, recognition, or entry into a practice. Situated accounts of learning are relevant here because they treat changing participation in practice as part of learning rather than as a context external to it (Lave and Wenger 1991; Wenger 1998).

Economic conditions nonetheless matter to relational form. Time scarcity can shorten feedback cycles or make sustained mentoring difficult. Employment or household insecurity can reduce the learner's capacity to remain in an apprenticeship. Funding rules can reward large-group delivery over individual diagnosis. Platform design can determine whether interaction is reciprocal or one-directional. Credential competition can alter peer cooperation. GRE can reconstruct these mechanisms while leaving the educational adequacy of the relation open to domain-specific inquiry.

Proposition 23.230 (Learning-relation non-reduction). *The economic accessibility, cost, or intensity of a learning relation should not be treated as sufficient evidence of its educational generativity unless educational inquiry also supports the mechanism through which participation in that relation changes later understanding, capability, judgment, or participation.*

This proposition also allows education to correct GRE. If educational inquiry shows that a relation GRE treated as a transferable service depends on developmental sequencing, tacit recognition, embodied practice, trust, or a community norm, the economic model may need to revise its unit of analysis. The relevant economic object can shift from an isolated instructional input toward a relation or institutional configuration whose continuity has economic consequences.

23.10.2 Capability Generation

Capability generation sharpens the boundary between education and resource transfer. GRE has repeatedly distinguished possession of a resource from the capability to mobilize it. Education makes this distinction especially visible because immediate performance can be produced through assistance, memorization, imitation, or highly specific support while later independent or adaptive capability remains weak.

Definition 23.231 (Educational capability-generation interface). An *educational capability-generation interface* specifies the educational capability under investigation, the resources and relations through which it is expected to form, the learner's prior position, the forms of supported and unsupported performance observed, evidence of transfer or regeneration across changed conditions, the economic resources required for continuation, and the educational warrant for treating the observed change as capability rather than temporary performance.

The interface can incorporate capability-oriented economic analysis without reducing educational formation to later earnings or productivity. Sen's capability approach is relevant because it distinguishes resources from substantive opportunities to act, while GRE adds a temporal question about how those capabilities are generated and regenerated through relations (Sen 1999). Educational theory can then ask which practices, sequences, explanations, feedback forms, or curricular structures actually produce the relevant capability.

This distinction matters acutely under artificial assistance. A learner can complete a task with an AI system while remaining unable to verify the result, reconstruct the reasoning, transfer the method, or notice when the system fails. Chapter 19 described this as assistance-to-capability conversion. At the interface level, the economic question concerns access to assistance, its distribution, cost, dependency, and downstream capability consequences; the educational question concerns the constitution of learning under assisted conditions.

Proposition 23.232 (Capability-generation warrant). *A GRE claim that an educational arrangement generates capability should distinguish resource receipt and supported performance from evidence of durable, transferable, or regenerable capacity, and should defer the educational constitution of that capacity to appropriate pedagogical or domain-specific warrant where necessary.*

The proposition prevents capability language from becoming a broad positive label for educational spending or attainment. It also creates a correction path. If later educational evidence shows that a supposedly durable capability depends on continuous hidden support, narrow task familiarity, or institutional recognition that does not travel across settings, GRE should revise the claimed option-space expansion or generative return.

23.10.3 Curiosity

Curiosity is economically conditioned but not well represented as a stable preference whose intensity can simply be observed and priced. Earlier chapters treated curiosity as part of the sequence through which encounters become questions and sustained inquiry. Education provides one of the principal environments in which that capacity can be enlarged, narrowed, rewarded, redirected, or made costly.

Definition 23.233 (Curiosity-support interface profile). *A curiosity-support interface profile records the learner's opportunities for encounter and exploration, available discretionary time, material security, access to mentors, texts, tools, environments, and communities, institutional incentives and penalties for question formation, the range of questions treated as admissible, observed persistence of inquiry, and educational evidence concerning how curiosity is cultivated or inhibited.*

GRE can analyze the distribution of conditions in this profile. Quiet space, language access, libraries, laboratories, field experience, mobility, mentorship, broadband, computational resources, and freedom from immediate insecurity are not evenly distributed. Examination systems and labor-market pressures can also alter the opportunity cost of open-ended inquiry. Veblen's discussion of "idle curiosity" remains useful as an early account of inquiry whose value is not exhausted by immediate utility (Veblen 1914). The present interface adds a distributional question: who can afford to sustain such inquiry, and through which educational arrangements does curiosity become a capability rather than a fleeting disposition?

Educational theory supplies a different warrant. It can investigate developmental timing, appropriate challenge, problem situations, intrinsic and extrinsic motivation, classroom climate, teacher response, disciplinary norms, and the relation between curiosity and understanding. Dewey's treatment of inquiry and problematic situations is relevant here because it connects learning with active reconstruction rather than passive reception (Dewey 1910). GRE can study the conditions under which such environments become materially available without presuming to derive the pedagogy from those conditions.

Proposition 23.234 (Curiosity non-instrumentality condition). *GRE should not treat curiosity as educationally valuable only when a direct productivity, earnings, or innovation pathway is already identifiable; it may analyze the economic conditions that widen or restrict open-horizon inquiry while leaving the educational and intrinsic significance of curiosity partly outside economic valuation.*

The condition matters especially in rapidly changing knowledge environments. A question that appears economically peripheral at one moment can later become consequential, but uncertainty about future usefulness is not the only reason to preserve curiosity. The interface therefore protects a domain-specific remainder even while GRE studies the resource architecture that makes curiosity unequally possible.

23.10.4 Aesthetic Judgment

Aesthetic judgment enters the education interface through orientation. Learners and educators encounter more possible texts, models, examples, explanations, projects, styles, and generated artifacts than can be pursued equally. Judgment helps orient attention among alternatives, but the relevant judgments are neither reducible to truth conditions nor safely inferred from market demand or popularity.

Definition 23.235 (Educational aesthetic-judgment interface). An *educational aesthetic-judgment interface* records the field of alternatives from which a learner or educator selects, the qualities perceived as elegant, fitting, coherent, striking, fertile, or well formed, the educational task for which those qualities matter, the social and institutional conditions shaping exposure and recognition, later epistemic or practical consequences, and the boundary between aesthetic orientation and evidential warrant.

The interface builds on the distinction developed in Chapter 6: aesthetic judgment can orient inquiry without directly establishing truth. Kant's treatment of aesthetic judgment and Dewey's processual account of aesthetic experience provide contrasting resources for thinking about the structure of such judgment (Kant 1987; Dewey 1934). GRE's concern is narrower. Abundance, platform ranking, curricular time, institutional prestige, cost, and access can influence which forms and examples a learner encounters and which judgments are reinforced. These conditions can become economically unequal even when the educational meaning of the judgment cannot be reduced to an economic variable.

Aesthetic judgment is also field-specific. Elegance in a proof, explanatory economy in a theory, balance in a design, expressive adequacy in a performance, and coherence in an argument are not interchangeable properties. Educational inquiry is needed to determine how learners acquire the perceptual and evaluative capacities appropriate to a practice, how those capacities relate to standards and criticism, and when they should remain open to revision.

Proposition 23.236 (Aesthetic-orientation non-proxy). *Neither market valuation, institutional prestige, popularity, nor immediate performance should be used as a general proxy for educationally relevant aesthetic judgment; GRE may study the economic conditions shaping exposure and selection while educational and aesthetic inquiry retain responsibility for the judgment's domain-specific formation and significance.*

This proposition anticipates the more explicit aesthetics interface developed later in Chapter 23. The educational interface is narrower: it asks how learners acquire orientation capacities within practices and how economic conditions shape the space in which those capacities can develop.

23.10.5 Epistemic Participation

Learning becomes more than private acquisition when learners enter practices in which they can ask questions, interpret evidence, contribute artifacts, receive criticism, revise claims, teach others, and participate in the reproduction of knowledge. Chapter 17 described epistemic participation as a relational economic object. The education interface asks when access to an epistemic setting becomes consequential participation and how educational formation changes the learner's position within it.

Definition 23.237 (Educational epistemic-participation profile). *An educational epistemic-participation profile records the practice or knowledge community entered, the learner's initial position, access and language conditions, opportunities to observe, question, contribute, verify, receive feedback, and exercise judgment, the distribution of recognition and responsibility, changes in capability and standing over time, and the economic and educational barriers affecting continued participation.*

Participation can therefore differ from mere presence. Enrollment in a university, access to an online course, attendance at a laboratory, or membership in a professional platform does not establish that the learner has entered the epistemic relations through which capability and standing develop. Time, confidence, language, equipment, social recognition, disability access, mentoring, institutional status, and economic security can condition whether formal access becomes effective participation.

The distinction is particularly important where AI makes symbolic production cheap. A learner may generate polished text, code, images, or analyses without acquiring a stronger position in the epistemic process of problem formation, verification, critique, and responsibility. Conversely, AI can widen participation when it reduces language, explanation, or access barriers and supports learners in entering practices previously beyond reach. The interface should therefore track the learner's changing epistemic role rather than output volume alone.

Proposition 23.238 (Participation-conversion condition). *Formal access to an educational or epistemic setting should be treated as stronger educational participation only when the learner acquires consequential opportunities to understand, question, contribute, receive correction, exercise judgment, and assume progressively meaningful roles within the relevant practice.*

Educational inquiry can return corrections here as well. If a participation measure based on attendance, platform activity, publication count, or credential acquisition fails to capture actual entry into a practice, GRE should revise the economic relation it associates with participation and avoid treating nominal activity as capability generation.

23.10.6 Educational Infrastructure

Educational infrastructure connects the economic and educational domains because it is materially costly, institutionally maintained, and often publicly financed, yet its educational value depends on use relations that cannot be inferred from provision alone. Buildings, teachers, libraries, laboratories, networks, archives, curricula, accessibility systems, platforms, translation resources, assessment systems, and AI tools can all function infrastructurally when they sustain recurrent learning across learners and cohorts.

Definition 23.239 (Educational-infrastructure interface record). An *educational-infrastructure interface record* specifies an infrastructural component, its financing and maintenance, labor and governance requirements, intended learners and uses, accessibility and interoperability conditions, pedagogical functions, dependency and failure modes, replacement and repair pathways, temporal durability, and evidence that the infrastructure is educationally usable rather than merely nominally available.

The distinction between availability and usability is central. A broadband connection does not guarantee accessible content. A laboratory does not guarantee supervised entry into experimental practice. A library does not guarantee language access or the ability to navigate its classifications. A teacher position does not guarantee enough time for feedback. An AI platform does not guarantee verification capacity or continuity if access terms change. Economic analysis can identify the resource and maintenance structure; educational inquiry can determine whether the configuration supports the intended learning processes.

Infrastructure also has temporal depth. Teacher formation, mentoring systems, archives, curriculum knowledge, technical maintenance, and institutional memory can be depleted while current performance remains superficially stable. Cost reduction that removes the very relations through which tacit knowledge or feedback is reproduced can therefore generate infrastructure debt. Conversely, automation or shared infrastructure can free resources for richer educational relations when the savings are actually converted into access, feedback, teacher support, or new learning pathways.

Proposition 23.240 (Educational-infrastructure usability condition). *Educational infrastructure should be treated as effectively available only when relevant learners can enter, use, interpret, and continue relying on it under the conditions required by the educational process, with maintenance and repair sufficient to preserve the relation across the relevant horizon.*

The proposition brings educational correction into infrastructure economics. If a cost model treats teachers, mentors, or community practices as substitutable inputs but educational evidence shows that some carry non-substitutable developmental functions, the economic representation should change rather than treating the pedagogical remainder as noise.

23.10.7 Knowledge Communities

Knowledge communities provide the relational setting in which educational capability can become socially consequential. They preserve standards, practices, questions, language, memory, and opportunities for contribution. Learners can enter them

gradually, and established participants can reproduce or close the pathways through which future members acquire standing.

Definition 23.241 (Knowledge-community education interface). A *knowledge-community education interface* records the community or practice, entry pathways, mentorship and peer relations, infrastructures and shared resources, recognition rules, contribution opportunities, tacit and codified knowledge, reproduction responsibilities, exclusion mechanisms, economic conditions of participation, and the learner's changing position within the community over time.

This interface extends the communities-of-practice insight that learning involves changing participation in socially organized practice (Lave and Wenger 1991; Wenger 1998). GRE can study the economic architecture that supports or inhibits such communities: funding for mentorship, time for apprenticeship, career structures, geographical concentration, digital access, language barriers, precarious employment, ownership of shared infrastructure, and incentives affecting whether established members teach, document, or reproduce practice.

Community reproduction can fail despite strong individual output. A research group can publish extensively while weakening mentoring. A professional field can produce high earnings while narrowing entry pathways. A school can raise test scores while exhausting teachers. A knowledge platform can increase content volume while concentrating moderation, verification, or archival control. The generative object is therefore not aggregate output alone but the capacity of the community to form future participants and revise its practices.

Proposition 23.242 (Knowledge-community reproduction condition). A *knowledge community has stronger educational generativity when participation pathways, mentoring, standards, shared resources, criticism, and opportunities for contribution enable successive participants to acquire and revise the capabilities needed to sustain the practice without relying on hidden depletion of its relational or infrastructural base.*

Educational inquiry can correct GRE by revealing that the relevant unit is a community trajectory rather than an individual learner or organization. It can also expose tacit dependencies that are invisible in monetary flows. These findings should be allowed to revise economic assessments of educational productivity and return.

23.10.8 Economic Conditions of Education

The previous subsections identify educational objects that should not be reduced to economics. The interface nevertheless requires a positive account of what GRE contributes. Education depends on scarce time, labor, material resources, household conditions, public finance, organizational capacity, transport, housing, digital systems, language infrastructure, care, and the distribution of security. Economic relations also shape who can postpone earnings, relocate, undertake unpaid practice, access elite networks, purchase assistance, or absorb educational failure.

Definition 23.243 (Educational economic-condition profile). An *economic-conditions-of-education profile* records the resources, income and security conditions, time budgets, household and care relations, teacher and staff labor conditions, institutional finance, geographic and digital access, opportunity costs, credential incentives, market and public provisioning, technological dependencies, and distributional asymmetries that shape entry into and persistence within an educational process.

The profile should be linked to conversion rather than treated as a list of inputs. Two learners receiving the same nominal scholarship can face different housing, care, disability, language, transport, legal, or household constraints. Two schools with similar budgets can differ in teacher turnover, institutional memory, community trust, or infrastructure quality. Two countries can expand enrollment while producing different capability trajectories because educational relations and institutional conditions differ. GRE's contribution is to reconstruct how resources and economic positions become, or fail to become, usable educational possibility.

Human-capital analysis remains relevant where education affects productivity, employment, and earnings (Becker 1964). The interface widens rather than rejects that analysis. Earnings are one economic consequence among several; educational arrangements can also alter future learning, mobility, participation, knowledge reproduction, institutional capacity, and the ability to reorient under technological or social change. These effects can have economic importance even when they are weakly represented by near-term wages.

Proposition 23.244 (Educational access–conversion distinction). *Equal or expanded provision of educational resources should not be interpreted as equal educational opportunity unless the analysis also addresses the economic and relational conditions through which nominal access is converted into usable participation, capability, and future options.*

This distinction makes educational inequality more than a resource-gap problem while preserving the economic relevance of resources. It also allows educational theory to return evidence that some conversion conditions have been misidentified. A GRE model can then revise its incidence analysis, capability profile, or estimate of generative educational return.

23.10.9 Limits of Economic Reduction

The education interface becomes most important where economic observables are informative but insufficient for the principal claim. Education can affect productivity, earnings, fiscal capacity, labor-market mobility, innovation, and institutional performance. Yet the educational significance of learning relations, curiosity, judgment, development, cultural transmission, play, identity, care, or entry into a practice cannot be established by those consequences alone.

Definition 23.245 (Economic-reduction signal in education). *An economic-reduction signal in education is present when a claim concerning educational quality, learning, development, curiosity, judgment, pedagogical adequacy, or educational purpose is inferred principally from resource expenditure, productivity, earnings, credential value, test-linked incentives, market demand, institutional revenue, or aggregate economic return without an independently warranted educational bridge.*

Several recurrent reductions follow this pattern. Teaching can be represented as a labor input without identifying the relation through which learning occurs. Curiosity can be treated as a preference for information. Judgment can be proxied by performance on familiar tasks. A knowledge community can be represented as a production network without examining mentorship or practice reproduction. A school can be evaluated as an output-generating organization while its developmental, cultural, or relational functions remain invisible. These representations may answer bounded economic questions, but they become inadequate when used to settle edu-

cational ones.

Proposition 23.246 (Educational explanation handoff). *When the principal explanatory or evaluative burden of an inquiry depends on specifically educational concepts whose content cannot be supplied by economic relations alone, the inquiry should move to educational theory, adopt joint GRE–education governance, or narrow its GRE claim to the economic conditions and consequences that GRE can warrant.*

A disciplined interface also requires correction in the reverse direction. Educational theory can show that GRE has misidentified the relevant learner, treated a developmental sequence as freely reorderable, mistaken assisted performance for capability, compressed participation into attendance, ignored tacit mentorship, or evaluated infrastructure without regard to pedagogical usability. Such findings can change the economic object itself.

Definition 23.247 (Education correction return). *An education correction return is a documented finding from educational inquiry that requires GRE to revise an economic object, relation, capability claim, participation measure, infrastructure assessment, temporal horizon, community boundary, generative-return estimate, or scope claim because the prior economic formulation depended on an inadequate educational characterization.*

The correction can work in the opposite direction as well. GRE can return evidence that an apparently pedagogical problem is being materially conditioned by time poverty, teacher precarity, unequal household resources, infrastructure ownership, credential incentives, platform dependence, or unequal access to knowledge communities. The interface is strongest when neither side treats these returns as secondary commentary.

Definition 23.248 (GRE–education interface portfolio). *A GRE–education interface portfolio is a versioned collection of learning-relation profiles, capability-generation interfaces, curiosity-support profiles, aesthetic-judgment interfaces, epistemic-participation profiles, infrastructure records, knowledge-community interfaces, economic-condition profiles, correction returns, non-equivalent concepts, and unresolved educational boundary questions maintained across projects.*

The portfolio makes recurrent translation problems visible. It can show whether economic studies repeatedly treat provision as participation, whether capability claims are being inferred from supported performance, whether teacher labor is modeled without relational function, or whether educational return is being compressed into earnings despite evidence of longer-horizon capability and community effects.

Proposition 23.249 (GRE–education interface answerability). *A GRE–education interface is answerable when the economic condition or consequence, the educational claim, the translation path, the evidential source, the domain-specific remainder, and the possible education correction return are explicit enough that contrary educational analysis can revise the GRE interpretation or reclassify the inquiry.*

This condition preserves a productive but bounded education interface. GRE can investigate how economic arrangements condition access to learning, capability generation, curiosity, epistemic participation, infrastructure, and knowledge communities, and how educational trajectories later reshape economic possibility. Generative Relational Education retains independent responsibility for the constitution of learning, pedagogical adequacy, developmental formation, educational judgment, and ed-

educational purpose. The next interface turns to ecology, where the boundary problem changes again because economic relations interact with ecological constraints, non-human subjects, resource flows, and values that can resist economic commensuration.

23.11 Generative Relational Ecology Interface

Chapter 19 treated ecology as a substantive economic domain in which material and energy flows, ecological constraints, stewardship institutions, commons, regenerative capacities, and intergenerational consequences enter the constitution of economic possibility. The present section has a different role. It specifies the interface between GRE and a prospective Generative Relational Ecology programme without converting ecological inquiry into an enlarged branch of economics. Its objective is to identify which ecological relations GRE can investigate through economic dependence, incidence, allocation, conversion, circulation, maintenance, and future option structure; which claims require specifically ecological, biological, ethical, legal, or political warrant; and how ecological findings can return corrections to GRE. The section develops nine interfaces: human–environment relations, non-human subjects, ecological constraints, resource flows, social metabolism, stewardship, intergenerational relations, ecological value, and limits of economic commensuration. The method follows the containment and translation disciplines established in Sections 23.2–23.3. It also carries forward the multiscale discipline of Sections 23.4–23.5: ecological relations have histories, characteristic rates, spatial extents, and threshold-sensitive dynamics that need not coincide with economic accounting periods or institutional jurisdictions.

Definition 23.250 (GRE–ecology interface record). *A GRE–ecology interface record specifies the ecological configuration and economic positions under investigation, the human and non-human affected entities or processes, the material and energy flows involved, the biophysical constraints and uncertainties, the economic dependencies and incidence pathways, the stewardship or governance arrangements, the relevant temporal and spatial scales, the ecological claims requiring domain-specific warrant, the forms of value being represented or left non-commensurated, and the GRE claims that would require revision if the ecological characterization changes.*

The record separates several questions that are often compressed into one environmental variable. What ecological process or relation is changing? Through which economic activities, infrastructures, institutions, or consumption patterns does that change become consequential? Which persons, organizations, communities, species, populations, or ecological processes are affected? Which of those affected positions count as subjects, rights-holders, represented interests, or objects of stewardship under the relevant ecological, ethical, legal, or political framework? Which effects are economically measurable, and which remain material even when no defensible common metric exists? These questions can interact strongly without sharing one source of warrant.

Proposition 23.251 (Ecological-domain handoff condition). *A GRE inquiry should hand a material subquestion to ecological or neighboring domain inquiry when resolution of that subquestion depends principally on ecological function, species or ecosystem relations, non-human subjecthood, ecological integrity, conservation or*

Table 23.11: Principal operations at the GRE–ecology interface

Interface object	GRE contribution	Ecological-domain question	Return to GRE
Human–environment relations	Dependence, incidence, access, infrastructure, livelihood, spatial displacement	Which ecological relations and processes constitute the relevant configuration?	Revised economic boundary and dependency map
Non-human subjects	Affectedness, representation costs, economic incidence, stewardship relations	Which non-human entities are subjects, agents, represented interests, or ecologically significant relations?	Revised subject and affected-position architecture
Ecological constraints	Scarcity, exposure, adaptation capacity, economic conversion of limits	Which biophysical rates, thresholds, irreversibilities, and uncertainties constrain the system?	Revised feasible set, horizon, and risk structure
Resource flows	Extraction, throughput, transport, use, recirculation, waste, burden shifting	Which material–energy transformations and ecological sinks or sources are materially relevant?	Revised incidence and supply-chain boundaries
Social metabolism	Institutions, technologies, labor, infrastructures, throughput, distribution	How do coupled socio-ecological transformations persist or reorganize?	Revised process and reproduction model
Stewardship	Cost, labor, capability, authority resources, maintenance finance	What ecological knowledge, practices, and responsibilities constitute adequate stewardship?	Revised maintenance and generative-return claims
Intergenerational relations	Inheritance, option loss, delayed incidence, investment, discounting	Which ecological conditions and regenerative capacities are transmitted across generations?	Revised temporal horizon and future-option analysis
Ecological value	Economic manifestation, heterogeneous valuation, conversion and recognition regimes	Which ecological values or significances remain irreducible to economic valuation?	Revised value plurality and conversion boundaries
Commensuration limit	Economic comparison where warranted	Where does common scaling erase ecological relation, threshold, standing, or value?	Partial ordering, non-comparison, or domain handoff

restoration standards, moral or legal standing, or other domain-specific judgments that cannot be established from economic dependence, incidence, or valuation alone.

The handoff does not make ecology external to economics. Economic activity can alter habitats, hydrology, soils, atmospheric conditions, species interactions, nutrient cycles, and regenerative capacities, while ecological change can reorganize livelihoods, infrastructure, health, productivity, migration, insurance, public finance, and future option sets. Ecological economics has long emphasized such coupled relations, thermodynamic irreversibility, and regeneration constraints (Costanza 1989; Georgescu-Roegen 1971; Daly 1990). The interface question is therefore not whether ecology matters economically, but how to preserve the difference between an economic account of ecological consequence and an ecological account of the processes and values through which those consequences arise.

Table 23.11 summarizes the principal operations developed below.

23.11.1 Human–Environment Relations

Human–environment relations provide the first interface because the word *environment* can conceal the relations that make ecological conditions economically consequential. Water is not merely an external stock when its availability depends on a watershed, seasonal flow, upstream land use, treatment infrastructure, legal access, and maintenance institutions. Soil is not simply a productive input when fertility depends on biological activity, erosion, nutrient cycling, cropping practice, and historical land use. A coastal zone can simultaneously participate in livelihood, habitat, protection, transport, tourism, cultural meaning, and risk. GRE can trace the economic relations generated through these configurations, but it should not infer the

ecological architecture from the economic manifestations alone.

Definition 23.252 (Human–ecological interface profile). A *human–ecological interface profile* records the human positions and ecological entities or processes linked in a specified configuration, the forms of dependence and intervention, the spatial and temporal extent of the relation, the economic benefits and burdens, the infrastructures and institutions mediating the relation, the ecological processes whose characterization requires domain-specific evidence, and the boundary conditions under which the relation changes.

The profile resists two opposite simplifications. The first treats ecological processes as an external background against which economic activity takes place. The second treats every ecological relation as already economically legible once a price, service value, or cost estimate has been assigned. Ecosystem-service valuation can make otherwise invisible dependencies salient (Costanza et al. 1997), but a valuation is a representation of specified benefits or losses, not an exhaustive description of the ecological relation. It can leave unrepresented ecological interactions, non-use significance, uncertainty, thresholds, or values whose relevance does not depend on willingness to pay.

Spatial displacement is equally important. The location of consumption, ownership, or accounting can differ substantially from the location of extraction, habitat change, pollution, water use, or ecological risk. A GRE analysis therefore needs to distinguish the economic site from the ecological footprint of the relation. This is especially important where distant communities, ecosystems, or future users bear burdens generated by present activity.

Proposition 23.253 (Ecological-boundary revision condition). *When ecological inquiry shows that a process materially relevant to an economic claim extends beyond the spatial, temporal, organizational, or jurisdictional boundary used by GRE, the economic configuration should be revised rather than treating the omitted ecological relation as an external residual.*

This proposition makes ecology capable of correcting the economic object itself. A firm boundary, national boundary, project period, or household unit can remain useful for some questions while being inadequate for others. The interface is answerable when the boundary is chosen because it preserves the material relation needed for the claim, not merely because it matches the available accounts.

23.11.2 Non-Human Subjects

Non-human subjects create one of the sharpest limits on economic reduction. Economic activity can affect animals, species populations, forests, rivers, soils, microbial communities, habitats, and ecological processes even when those entities do not enter institutions as human decision-makers. Yet affectedness does not by itself settle whether an entity should be understood as a subject, agent, rights-holder, represented interest, ecological unit, moral patient, or object of stewardship. These classifications belong partly to ecological, ethical, legal, political, and cultural inquiry.

Definition 23.254 (Non-human affected-position record). A *non-human affected-position record* specifies the non-human organism, population, ecological entity, or process under consideration, the economic activity or institution producing the relevant effect, the form and evidence of affectedness, the ecological relation in which the effect is situated, the representational mechanism through which the effect en-

ters human decision-making, and the unresolved questions of subjecthood, agency, standing, or value that require external warrant.

The record allows GRE to remain analytically useful before a complete theory of non-human subjecthood is available. A fishery collapse, habitat fragmentation, river contamination, pollinator decline, or soil degradation can have clear economic effects and can also matter ecologically in ways not exhausted by those effects. GRE can trace the distribution of costs, benefits, dependence, and stewardship obligations without declaring that market value determines the status of the affected entity.

Representation is a separate interface. Non-human ecological effects may enter institutions through scientific monitoring, ecological indicators, stewardship practice, legal representation, community knowledge, advocacy, or public administration. Such representation can be partial or contested. Institutional silence is therefore not evidence of ecological absence.

Proposition 23.255 (Affectedness–subjecthood non-equivalence). *Evidence that a non-human entity or ecological process is materially affected by economic activity is sufficient to justify inclusion in an economic incidence analysis where the effect is economically consequential, but it is not sufficient by itself to establish ecological subjecthood, agency, moral standing, legal personality, or the normative weight of the affected relation.*

The proposition keeps several debates open while preventing GRE from excluding non-human effects merely because institutional standing is unresolved. Ecological inquiry can later return a correction showing that GRE selected the wrong unit, ignored a constitutive species relation, or treated an ecosystem-level process as a set of independent resource stocks. The economic model should then change accordingly.

23.11.3 Ecological Constraints

Ecological constraints differ from institutional constraints because some relevant limits operate independently of whether economic actors recognize them. Regeneration rates, hydrological availability, assimilative capacity, habitat requirements, thermodynamic irreversibility, climatic conditions, or threshold-sensitive ecological processes can restrict feasible trajectories even when no price or rule represents them adequately. At the same time, their economic incidence is mediated through institutions, infrastructure, technology, wealth, mobility, insurance, and public capacity.

Definition 23.256 (Ecological-constraint interface profile). *An ecological-constraint interface profile records the biophysical process or limit, its spatial and temporal scale, the ecological evidence supporting it, uncertainty and threshold conditions, the economic activities depending on or altering it, the conversion mechanisms through which the constraint becomes economically consequential, the affected economic positions, and the conditions under which the constraint profile requires revision.*

The interface distinguishes a physical constraint from the economic scarcity that may follow from it. A water limitation can generate different economic consequences under different allocation rules, storage systems, crop choices, pricing arrangements, public infrastructures, or migration capabilities. Conversely, a low price can coexist with an ecologically critical dependency when institutions fail to represent depletion or threshold risk.

Threshold-sensitive dynamics require particular restraint. Resilience research

has emphasized that persistence under disturbance is not the same as local stability around an equilibrium (Holling 1973). Earth-system research likewise illustrates how interacting processes can generate rising risks beyond simple linear scarcity (Steffen et al. 2015). GRE can represent the economic consequences of such conditions, but the ecological threshold itself requires ecological evidence and should not be inferred from market response.

Proposition 23.257 (Constraint representation discipline). *An ecological constraint should not be replaced by its economic manifestation when the ecological process has independent dynamics, uncertainty, thresholds, irreversibility, or cross-scale effects material to the claim; the economic representation should remain linked to the ecological evidence that defines the feasible or risky region.*

This condition is especially important for long-horizon policy. If a model updates only when scarcity becomes economically visible, it can respond after ecological deterioration has already narrowed the feasible set. Ecological information can therefore legitimately enter GRE before a fully realized price or income effect exists.

23.11.4 Resource Flows

Resource flows connect economic organization with material and energy transformation. Extraction, transport, processing, use, recirculation, waste, emissions, dissipation, and assimilation occur through physical pathways that can cross firms, households, jurisdictions, ecosystems, and generations. Monetary accounts can track some of these movements while obscuring others, particularly where ecological burdens are displaced spatially or temporally.

Definition 23.258 (Ecological resource-flow interface record). *An ecological resource-flow interface record specifies the material or energy entity, extraction or source relation, transformation stages, transport and storage, use, recirculation or substitution, residual and waste pathways, ecological sinks or accumulation points, institutional ownership or control positions, economic value flows, and ecological burdens that may occur outside the principal accounting boundary.*

This record makes resource circulation different from value circulation. Material can leave one jurisdiction while monetary value remains elsewhere; waste can accumulate after the economic transaction is complete; recycling can recover material while requiring additional energy or creating new residuals; a substitution can reduce one ecological pressure while increasing another. The thermodynamic emphasis in ecological economics is relevant because economic transformation cannot be represented as costless reversible circulation (Georgescu-Roegen 1971).

Proposition 23.259 (Flow-incidence completeness condition). *An economic evaluation of a resource-flow intervention is incomplete where materially relevant extraction, transformation, displacement, dissipation, accumulation, or ecological assimilation occurs outside the accounting boundary and could alter the incidence or long-horizon feasibility of the arrangement.*

The condition does not require every study to model the entire planetary lifecycle of every input. It requires proportional boundary expansion when omitted stages are material to the claim. Ecological inquiry can therefore return evidence that an apparently efficient economic transformation is burden shifting rather than net reduction, and GRE should revise its incidence and generative-return assessment.

23.11.5 Social Metabolism

Social metabolism provides a wider interface for studying recurring patterns of extraction, transformation, circulation, consumption, maintenance, and residual production. The term is useful when economic reproduction depends on continuing material and energy throughput organized by institutions, infrastructures, technologies, labor, settlement patterns, and cultural practices. It should not be interpreted as a claim that society is literally an organism. Its analytical value lies in connecting economic organization to recurrent physical transformations and the institutions that stabilize them.

Definition 23.260 (Social-metabolic interface profile). *A social-metabolic interface profile records a historically situated pattern of material and energy acquisition, transformation, distribution, use, maintenance, recirculation, and residual production together with the technologies, infrastructures, labor relations, institutions, spatial arrangements, and ecological dependencies that reproduce the pattern.*

The profile allows GRE to ask why a throughput pattern persists even when alternative technologies exist. Sunk infrastructure, housing form, transport networks, property relations, industrial standards, consumer routines, supply-chain organization, employment dependence, and public revenue can make one material regime self-reinforcing. Ecological inquiry can simultaneously identify pressures or regenerative limits that the economic institutions do not represent.

Proposition 23.261 (Metabolic reproduction condition). *A socially organized material-energy regime should be analyzed as a reproduced configuration when its continuation depends on mutually reinforcing economic institutions, infrastructures, practices, and ecological dependencies rather than on isolated resource choices alone.*

This proposition connects ecology with GRE's broader interest in generative and reproductive structures. A transition in social metabolism can therefore require more than substitution of one input. It may involve changes in infrastructure, employment, skills, finance, regulation, settlement, maintenance, and collective expectations. The ecological interface helps identify which physical relations must change; GRE can then analyze the economic conversion costs and distributional consequences of that change.

23.11.6 Stewardship

Stewardship concerns the relations through which ecological conditions are observed, maintained, restored, governed, and transmitted. Chapter 19 distinguished stewardship from ownership because legal title or economic control does not guarantee ecological knowledge, maintenance capacity, or long-horizon responsibility. The interface developed here asks which parts of stewardship GRE can analyze economically and which require ecological or governance warrant.

Definition 23.262 (Stewardship interface record). *A stewardship interface record specifies the ecological configuration to be maintained or restored, the persons and institutions performing stewardship, the ecological knowledge and practices involved, the labor, time, resources, authority, monitoring, and succession conditions, the economic burdens and benefits, the distribution of control and responsibility, and the ecological and governance questions that remain outside GRE's independent warrant.*

Economic analysis can identify whether stewardship labor is compensated, whether maintenance funding is durable, whether incentives favor short-horizon extraction, whether local knowledge holders bear uncompensated costs, whether property or contracting structures fragment responsibility, and whether restoration benefits are captured elsewhere. Yet ecological adequacy depends on the actual system being stewarded. A financially sustainable programme can still be ecologically ineffective; an ecologically effective practice can remain institutionally or distributively unjust.

Proposition 23.263 (Stewardship non-equivalence). *Ownership, control, payment, or formal responsibility should not be treated as sufficient evidence of ecological stewardship; stewardship requires domain-specific evidence that the relevant ecological relations are being observed, maintained, restored, or adaptively managed through adequate knowledge and practice.*

The proposition also prevents the opposite reduction. Ecological effectiveness does not by itself settle questions of authority, participation, legal duty, or distributive justice. Those questions may require GRG, GR-Law, political theory, or ethics. The ecology interface therefore often becomes a multi-domain junction rather than a bilateral exchange between GRE and ecology alone.

23.11.7 Intergenerational Relations

Ecological relations often persist beyond the horizon of present contracts, projects, budgets, or lifetimes. Depletion, contamination, habitat fragmentation, infrastructure lock-in, restoration, soil formation, climate processes, and institutional learning can transfer conditions to people who did not participate in the original decision. Intergenerational analysis therefore requires more than extending a conventional cost stream farther into the future.

Definition 23.264 (Ecological intergenerational interface profile). *An ecological intergenerational interface profile records the ecological conditions, infrastructures, institutions, knowledge, burdens, regenerative capacities, and option structures transmitted from one temporal cohort to later cohorts; the mechanisms of transmission; uncertainty and irreversibility; the economic valuation or discounting conventions used; and the domain-specific ecological or normative questions that cannot be settled by present economic preferences alone.*

The profile distinguishes future economic incidence from the normative standing of future persons or non-human life. GRE can estimate delayed costs, adaptation burdens, investment needs, productivity effects, insurance exposure, or lost options. It can also examine how present institutions privilege short-horizon claims. But it cannot derive the correct intergenerational obligation simply from a discount rate or projected willingness to pay.

Proposition 23.265 (Future-option preservation distinction). *Preservation of future ecological and economic option structures should be analyzed separately from maximization of a present-valued aggregate whenever irreversible or threshold-sensitive ecological change can remove options whose later significance cannot be adequately represented by present preferences or prices.*

This proposition does not prescribe one rule of conservation. It requires that irreversible narrowing of future possibility remain visible as its own analytical consequence. Ecological inquiry can return information about regenerative capacity or

threshold risk; political, legal, or ethical inquiry can address obligations and standing; GRE can analyze how alternative arrangements distribute the costs of preserving or losing future options.

23.11.8 Ecological Value

Ecological value is an interface because the same ecological configuration can matter through several non-equivalent relations. It can support livelihood, habitat, cultural identity, subsistence, recreation, scientific knowledge, resilience, sacred meaning, existence value, species continuity, or future ecological possibility. Some of these relations can be economically manifested; others can enter policy through ecological, cultural, legal, ethical, or political judgment.

Definition 23.266 (Ecological value interface profile). *An ecological value interface profile records the ecological entity or relation being evaluated, the persons or non-human positions to whom or through which it matters, the distinct value forms and manifestations identified, the recognition and measurement practices used, any conversion or aggregation rule, the uncertainty and exclusions introduced by that rule, and the value remainders that retain ecological or other domain-specific significance outside the economic metric.*

GRE's heterogeneous-value architecture is useful here because it does not require every value to become one substance before comparison. Monetary valuation can be informative for particular decisions, especially when it reveals dependencies or opportunity costs that institutions otherwise ignore. Yet a price may express one manifestation without exhausting the ecological relation. Likewise, biological indicators can represent ecological function without determining economic or moral priority.

Proposition 23.267 (Ecological value non-exhaustion). *An economic valuation of an ecological relation should be treated as exhaustive only where the research task, affected positions, value forms, and conversion assumptions justify that interpretation; otherwise the valuation remains one manifestation within a heterogeneous value architecture and material ecological remainders should remain explicit.*

The proposition preserves both comparability and restraint. It allows economic valuation where it is useful without turning non-monetized significance into zero value. It also permits ecological inquiry to return a correction when the economic representation omits a function, relation, threshold, or subject position material to the decision.

23.11.9 Limits of Economic Commensuration

The final interface concerns the limits of making heterogeneous ecological consequences commensurable. Commensuration can support budgeting, compensation, prioritization, cost comparison, or policy design. It can also erase differences among reversible and irreversible effects, local and systemic processes, human and non-human affectedness, thresholds and marginal changes, or values whose significance depends on relations rather than quantity alone.

Definition 23.268 (Ecological commensuration contract). *An ecological commensuration contract states the ecological and economic objects being compared, the common scale or conversion rule, the decision task for which the comparison is intended,*

the assumptions needed for comparability, the affected positions included, the temporal and spatial horizon, the ecological thresholds or non-substitutable conditions preserved outside the scale, and the circumstances under which the common metric should be suspended.

The contract makes commensuration task-relative. A monetary comparison can be appropriate for estimating compensation costs without being adequate for determining whether habitat loss is ecologically substitutable. A carbon-equivalent metric can assist emissions accounting while leaving biodiversity, toxicity, water, or place-specific relations outside its scope. A composite sustainability index can summarize selected dimensions while concealing threshold effects or unequal incidence. The analytical problem is therefore not whether commensuration is permitted in the abstract, but what claim a particular commensuration can support.

Definition 23.269 (Ecological non-commensuration remainder). An *ecological non-commensuration remainder* is a materially relevant ecological relation, threshold, subject position, uncertainty, value form, spatial specificity, temporal irreversibility, or regenerative condition that is not preserved by the adopted common metric and therefore remains separately visible in the analysis.

Proposition 23.270 (Ecological commensuration stopping condition). *Economic commensuration should stop short of a totalizing common metric when further aggregation would erase a material ecological threshold, non-substitutable relation, unresolved subject or standing question, irreversible loss, or domain-specific value necessary for the decision or claim under investigation.*

This stopping condition does not require universal incommensurability. It supports partial orderings, vector evaluations, threshold constraints, scenario comparisons, and domain-specific judgments where a single scalar would overstate comparability. It also keeps disagreement traceable: two parties may agree on the economic cost while disagreeing on ecological substitutability, standing, or value.

Definition 23.271 (Ecology correction return). An *ecology correction return* is a documented finding from ecological inquiry that requires GRE to revise an economic boundary, subject or affected-position classification, constraint profile, resource-flow map, metabolic process model, stewardship assessment, temporal horizon, value representation, or commensuration rule because the prior economic formulation depended on an inadequate ecological characterization.

The correction can also move in the opposite direction. GRE can return evidence that an ecological intervention is being undermined by livelihood dependence, financing structure, insecure tenure, supply-chain incentives, unequal adaptation capacity, maintenance underinvestment, or concentration of decision-making power. The interface is strongest when such returns change the receiving domain's model rather than appearing as ancillary commentary.

Definition 23.272 (GRE–ecology interface portfolio). A *GRE–ecology interface portfolio* is a versioned collection of human–ecological profiles and non-human affected-position records. It also preserves ecological-constraint profiles, resource-flow records, social-metabolic profiles, stewardship records, intergenerational profiles, ecological value profiles, commensuration contracts, non-commensuration remainders, correction returns, and unresolved boundary questions across projects.

Proposition 23.273 (GRE–ecology interface answerability). *A GRE–ecology interface is answerable when the ecological process, economic relation, affected positions, spa-*

tial and temporal scales, ecological evidence, economic consequence, value representation, non-commensurated remainder, and possible ecology correction return are explicit enough that contrary ecological analysis can revise the GRE interpretation or reclassify the inquiry.

This condition preserves a productive but bounded ecological interface. GRE can investigate how ecological dependence, resource flows, constraints, stewardship arrangements, and inherited ecological conditions shape economic possibility, and how economic organization feeds back into ecological trajectories. Generative Relational Ecology retains independent responsibility for ecological constitution, ecosystem- and species-specific relations, non-human subjecthood where relevant, ecological integrity, regenerative standards, and forms of ecological significance that do not derive their warrant from economic commensuration. The next interface turns to artificial intelligence, where the boundary problem shifts from human-ecological relations toward artificial agency, heterogeneous subjecthood, capability and epistemic asymmetries, institutional mediation, and the limits of GRE's economic scope.

23.12 Artificial Intelligence Studies Interface

Chapter 18 developed artificial intelligence as a substantive object of GRE through productive capacity, radical capability asymmetry, power conversion, labor, ownership, surplus, dependence, epistemic mediation, participation, heterogeneous subjects, and long-horizon institutional transformation. Chapter 22 then translated that architecture into a research programme. The present section has a different role. It specifies the interface between GRE and the wider field of artificial-intelligence studies without treating technical capability, artificial agency, subjecthood, institutional mediation, or normative status as questions that economics can settle by itself. Its objective is to identify which AI-related questions GRE can answer through economic relations, capabilities, dependence, allocation, value, power, participation, and institutional consequences; which questions require computer science, cognitive science, philosophy, law, political theory, education, sociology, ethics, or other domain-specific warrants; and how findings from those domains can return corrections to GRE. The section develops nine interfaces: artificial agency, heterogeneous subjecthood, capability asymmetry, epistemic asymmetry, dependence, human participation, AI-mediated institutions, economic and non-economic AI questions, and the limits of GRE scope. The method follows the containment and translation disciplines established in Sections 23.2–23.3. It also preserves the distinction, established throughout Part VII, between an economically consequential position and a complete ontology of the entity occupying that position.

Definition 23.274 (GRE-AI studies interface record). A *GRE-AI studies interface record* specifies the artificial system, model, toolchain, infrastructure, organization, and human or collective positions under investigation; the technically and institutionally available capabilities; the economic tasks and relations in which those capabilities are realized; the ownership, access, authorization, verification, and dependency conditions; the affected participation pathways; the AI-related claims that require non-economic warrant; the relevant uncertainties and version changes; and the GRE claims that would require revision if the technical, epistemic, institutional, or subjecthood characterization changes.

Table 23.12: Principal operations at the GRE–AI studies interface

Interface object	GRE contribution	AI-studies question	Return to GRE
Artificial agency	Delegation, economic action, authority chain, incidence, accountability costs	What operation is genuinely attributable to the system, its operators, or the wider sociotechnical configuration?	Revised agency and responsibility map
Heterogeneous subjecthood	Economic affectedness, participation, value incidence, relational position	What kind of subjecthood, if any, is warranted, and by which ontology or evidence?	Revised subject and standing architecture
Capability asymmetry	Practical realization, complements, access, substitutability, distribution	What technical capacities exist under specified conditions, and how robustly?	Revised capability comparison and feasible-set analysis
Epistemic asymmetry	Information access, verification cost, decision dependence, knowledge conversion	What epistemic functions are performed reliably, and with which uncertainty or failure modes?	Revised epistemic-dependence and authority claims
Dependence	Switching, fallback, lock-in, continuity, bargaining, capability erosion	Which technical and organizational dependencies are intrinsic, contingent, or reversible?	Revised dependency and power-conversion analysis
Human participation	Economic standing, task allocation, influence, future capability, option preservation	Which human contributions remain epistemically, institutionally, socially, or normatively constitutive?	Revised participation and generative-option architecture
AI-mediated institutions	Classification, ranking, allocation, monitoring, workflow, decision mediation	How does technical mediation alter institutional procedure, representation, and accountability?	Revised institutional boundary and mechanism model
Question allocation	Economic incidence and economic mechanism	Which questions belong principally to technical, legal, political, ethical, educational, or other domains?	Revised project governance and handoff structure
Scope limit	Explicit economic claim boundary	Which stronger AI claims exceed GRE warrant?	Contraction, reclassification, or joint inquiry

The record prevents the term *AI* from functioning as an undifferentiated causal variable. A foundation model, a specialized classifier, a recommender system, an autonomous toolchain, an embedded decision aid, and an institutionally delegated software agent can occupy very different economic positions even where they share components. Their significance can also change as interfaces, data access, compute, legal permissions, organizational workflows, or human verification practices change. GRE therefore needs a declared configuration before it can analyze incidence, productivity, bargaining, dependence, participation, or future option structure.

Proposition 23.275 (AI-domain handoff condition). *A GRE inquiry should hand a material AI subquestion to the relevant neighboring domain when resolution of that subquestion depends principally on technical capability, model architecture, robustness or safety, cognition, consciousness, subjecthood, moral standing, legal status, political legitimacy, pedagogical adequacy, or another domain-specific judgment that cannot be established from economic realization and consequence alone.*

The handoff is not a withdrawal from AI research. Economic organization shapes which systems are built, deployed, maintained, trusted, financed, governed, and made available; AI systems in turn can alter production, knowledge, labor, access, coordination, representation, and institutional decision. The interface question is therefore how to preserve these coupled relations without allowing economic consequence to substitute for the independent warrants required by other AI questions.

Table 23.12 summarizes the principal operations developed below.

23.12.1 Artificial Agency

Artificial agency is the first interface because an AI system can initiate or transform economically consequential operations without thereby settling what kind of agent it is in a broader philosophical, cognitive, legal, or moral sense. A software system can select bids, rank applicants, execute trades, schedule workers, generate contractual language, call external tools, adjust prices, or trigger workflow transitions. These operations can change access, cost, timing, risk, and bargaining position. GRE needs to represent such functional participation because leaving it invisible would misdescribe the economic process. Yet functional participation does not by itself establish consciousness, intention, autonomous authorship, legal personality, moral responsibility, or independent standing.

Definition 23.276 (Artificial economic-agency interface profile). An *artificial economic-agency interface profile* records the operation performed, the artificial component involved, the degree and scope of delegated discretion, the human or organizational objective-setting and authorization structure, the data and tools available to the system, the verification and override conditions, the legal and institutional bearer of consequences, the affected economic positions, and the broader agency claims that remain outside the economic description.

This profile treats agency as typed. The relevant economic question can be whether the artificial component selects among economically consequential alternatives within a delegated action space. A different question asks whether the system understands the action, forms intentions, possesses consciousness, or can bear duties. Those questions can be related, but they are not answered by the same evidence. The profile therefore records the operational contribution without using one vocabulary of agency to settle every domain at once.

Proposition 23.277 (Functional-agency non-equivalence). *Evidence that an artificial system performs delegated or semi-autonomous economic operations is sufficient to justify analysis of functional economic agency only within the stated operation and authority structure; it is insufficient by itself to establish general agency, subjecthood, consciousness, moral responsibility, or legal personality.*

The proposition also improves accountability analysis. When an AI-mediated action fails, a single label such as “the AI decided” can obscure the relations that produced the outcome. Model developers, deployers, data providers, interface designers, managers, users, and institutional rules can occupy different positions in the causal and authority chain. GRE can trace the costs, dependencies, incentives, and incidence produced by that chain. Legal, ethical, and technical inquiry can separately determine attribution and responsibility under their own standards.

Definition 23.278 (Delegated-operation responsibility map). A *delegated-operation responsibility map* identifies the technical component executing an operation, the positions setting objectives and constraints, the positions supplying data and infrastructure, the positions authorized to approve, override, or contest the result, the positions bearing economic gains and losses, and the unresolved legal, moral, or political responsibility questions requiring domain-specific determination.

23.12.2 Heterogeneous Subjecthood

Heterogeneous subjecthood becomes an interface when economic analysis includes humans, organizations, collectives, artificial systems, and other affected positions without presuming that all occupy the same ontological or normative category. GRE already uses relationally situated subjects and affected positions because economic incidence can fall on entities whose capacities, rights, or values differ. AI intensifies this issue. A system can influence decisions, generate representations, maintain interaction histories, or participate in production while its subject status remains contested or undefined.

Definition 23.279 (AI subjecthood interface record). An *AI subjecthood interface record* distinguishes the artificial system's functional economic position, relational persistence, capacity to initiate or respond within specified operations, representation by human or organizational actors, legal status, claimed or hypothesized cognitive properties, proposed moral or political standing, and the evidence or argument supporting each status separately.

The record allows GRE to remain operationally complete while ontologically restrained. Economic analysis may need to record that a model participates in a bargaining process or that users form durable relations with an artificial interface. Neither observation requires GRE to declare that the system is a subject in every relevant sense. Conversely, if independent inquiry were later to establish forms of artificial subjecthood or standing, GRE would need to revise its incidence, participation, ownership, or exploitation architecture accordingly.

Proposition 23.280 (Subject-status separation). *Functional economic participation, relational persistence, legal personality, moral standing, phenomenological subjecthood, and political membership should remain separately warranted statuses unless an explicit cross-domain argument establishes a valid relation among them.*

This separation is also important for human participants. Treating a human worker and an artificial system as two “agents” inside one optimization model can be useful for a narrow simulation, yet the representation may omit legal rights, vulnerability, embodiment, dependence, care relations, historical membership, or subjective continuity that are material to the economic question. Formal symmetry therefore should not be confused with ontological or normative symmetry.

Definition 23.281 (Heterogeneous-subject translation remainder). A *heterogeneous-subject translation remainder* is a material difference in embodiment, cognition, continuity, vulnerability, legal status, social membership, moral standing, institutional role, or value relation that is not preserved when human, artificial, organizational, or collective positions are represented through a common economic agent vocabulary.

23.12.3 Capability Asymmetry

Capability asymmetry provides a direct connection to Chapter 18, but the interface question differs from the substantive economic analysis undertaken there. GRE asks how technical differences become practically realizable economic capacities through access, complements, verification, institutions, cost, and control. AI studies can return corrections concerning what the system actually can do, under what conditions, with what reliability, and how rapidly those conditions are changing. The economic

comparison is therefore downstream of a technical characterization without being reducible to it.

Definition 23.282 (AI capability interface profile). An *AI capability interface profile* records the technical operation or benchmark, the system and version tested, evaluation conditions, uncertainty and failure modes, access and infrastructure requirements, human or organizational complements, economic workflow in which the capability is realized, substitutability and fallback conditions, persistence over time, and the economic consequences attributed to the capability difference.

This profile prevents benchmark performance from functioning as an economy-wide proxy. A model can exceed a human comparison group on one technical measure while remaining economically weak where verification is expensive, integration is poor, data are inaccessible, physical execution is required, or institutional authorization remains human-controlled. The reverse can also occur: a modest technical capability can become economically powerful when embedded in a high-frequency workflow with privileged access to data, distribution, or decision channels.

Proposition 23.283 (Technical-to-economic capability condition). A *technical AI capability* should enter a *GRE capability claim* only when the research design identifies the conditions through which that capability becomes practically available in the economic configuration and distinguishes the technical performance from the complementary resources, permissions, institutions, and verification practices required for realization.

Capability asymmetry also changes historically. Model updates, declining compute cost, new interfaces, regulation, open-source diffusion, organizational learning, or newly discovered failure modes can expand or contract the relevant asymmetry. Static comparison therefore has limited value for long-horizon claims.

Definition 23.284 (Capability-correction return). A *capability-correction return* is a documented technical or AI-studies finding that requires GRE to revise a capability comparison, feasible action set, substitutability assumption, workflow model, temporal horizon, or concentration claim because the prior economic analysis depended on an inaccurate or obsolete characterization of artificial capability.

23.12.4 Epistemic Asymmetry

Epistemic asymmetry concerns differences in the ability to retrieve, generate, organize, interpret, verify, and mobilize information or knowledge that matters for consequential action. Chapter 17 treated AI within the epistemic economy, and Chapter 18 examined epistemic dependence. The present interface adds a containment question: which part of an observed epistemic advantage is an economic position, and which part requires technical or epistemological analysis of reliability, provenance, uncertainty, representation, or reasoning?

Definition 23.285 (AI epistemic-asymmetry interface profile). An *AI epistemic-asymmetry interface profile* records the epistemic operation, the human and artificial positions compared, the information and tools available to each, the provenance and verification conditions, error and uncertainty characteristics, access and cost structure, institutional authority attached to the output, the downstream economic decision or capability affected, and the epistemic claims requiring non-economic warrant.

A large volume of generated text does not establish superior knowledge. High re-

trieval speed does not establish reliable interpretation. Accurate prediction in one environment does not establish epistemic authority outside its domain. GRE can study who bears verification costs, who controls access, how outputs alter bargaining or decision capacity, and where institutions delegate authority. Epistemology and AI evaluation remain responsible for stronger claims about truth-tracking, justification, robustness, or reasoning quality.

Proposition 23.286 (Epistemic-conversion condition). *An AI-mediated epistemic difference should be treated as an economically consequential asymmetry only when a traceable pathway connects the epistemic operation to altered decision quality, timing, access, bargaining, productive capability, institutional authority, or future economic possibility under stated verification and uncertainty conditions.*

This condition protects against two symmetric errors. One is to treat every improvement in information processing as economic transformation. The other is to ignore economic consequences until complete epistemological certainty is available. The interface allows graded claims: a system can alter verification cost or decision timing even when the truth status of some outputs remains uncertain, provided the economic mechanism is documented.

Definition 23.287 (Epistemic-authority remainder). *An epistemic-authority remainder is the part of an AI-mediated authority claim that depends on justification, expertise, reliability, provenance, interpretability, or institutional trust and therefore cannot be inferred solely from economic adoption, usage, market success, or decision impact.*

23.12.5 Dependence

Dependence becomes economically important when access to AI-mediated capacity conditions the ability of a person, organization, or institution to perform consequential operations or maintain future alternatives. Yet dependence is heterogeneous. Technical dependence on a model can differ from dependence on compute, data, a platform, an interface, proprietary formats, organizational permissions, or a small set of verification practices. Cognitive or skill dependence can also emerge when repeated assistance changes what human participants can do without the system.

Definition 23.288 (AI dependence interface profile). *An AI dependence interface profile records the function for which reliance exists, the technical and institutional layer on which it rests, the availability and cost of substitution, portability of data and workflows, fallback capacity, verification and maintenance requirements, contractual or access conditions, skill or knowledge changes associated with repeated use, and the economic consequences of interruption, degradation, or altered terms.*

The profile distinguishes reliance from stronger dependency. Using an AI system because it is convenient is different from reorganizing production so deeply around it that removal becomes costly or impossible. Dependence can also be beneficial in one sense while increasing vulnerability in another. A public institution may gain speed and consistency through a system while becoming dependent on an external provider for updates, audit access, or specialized knowledge.

Proposition 23.289 (Dependency-conversion condition). *AI reliance warrants a stronger GRE dependency claim when loss, degradation, or unilateral alteration of the relevant AI-mediated capability would materially contract the position's feasible operations or future alternatives and when switching, fallback, or endogenous replacement*

is sufficiently costly, delayed, or uncertain over the stated horizon.

Dependence can convert capability asymmetry into power, but the conversion is not automatic. A powerful provider may have little leverage where interoperability is high and switching is easy. A technically modest platform can become power-relevant where institutional workflows, data histories, or legal permissions make exit difficult. GRE should therefore analyze the relation rather than infer power directly from technical superiority.

Definition 23.290 (AI dependency correction return). *An AI dependency correction return is a finding from technical, organizational, or other neighboring inquiry that requires GRE to revise a dependency or power claim because fallback, interoperability, portability, hidden complementarity, skill retention, or infrastructure substitutability differs materially from the economic model previously assumed.*

23.12.6 Human Participation

Human participation is an interface because preserving a human presence in a workflow does not establish consequential participation. A person can remain nominally “in the loop” while possessing little capacity to frame the problem, inspect evidence, challenge outputs, change objectives, revise procedures, or refuse deployment. Conversely, AI assistance can expand human participation when it lowers technical barriers, improves access to information, or creates new forms of expression and coordination.

Definition 23.291 (Human participation interface profile). *A human participation interface profile records the human positions present in an AI-mediated process, the decisions and stages at which they can intervene, access to relevant information and alternatives, capacity to verify and contest outputs, authority to revise goals or procedures, ability to refuse or exit, opportunities to learn and retain independent capability, and the social, educational, legal, or political meanings of participation that remain outside the economic measure.*

The profile allows GRE to distinguish employment retention from participation, and task presence from influence. Human participation can matter economically through error correction, trust, adaptation, local knowledge, innovation, care, legitimacy-sensitive demand, and future skill formation. It can also matter beyond economics through dignity, citizenship, authorship, education, social membership, or meaning. The interface should preserve both kinds of significance without using one to stand in for the other.

Proposition 23.292 (Consequential-participation condition). *A claim that human participation is preserved in an AI-mediated economic process should identify at least one consequential channel through which human participants can affect problem framing, evidence, goals, verification, revision, institutional rules, or future alternatives; residual presence or ceremonial approval alone is insufficient.*

Participation also has a generative dimension. A workflow can produce high output while gradually weakening the participants’ ability to understand, revise, or recreate the process. GRE should therefore distinguish immediate productivity from preservation of later independent or collective capacity.

Definition 23.293 (Participation-capability retention record). *A participation-capability retention record tracks how repeated AI mediation changes human ca-*

pacities for independent performance, verification, problem formation, judgment, collaboration, institutional revision, and alternative generation over time, together with the economic and non-economic consequences of those changes.

23.12.7 AI-Mediated Institutions

Institutions become AI-mediated when artificial systems participate materially in classification, ranking, allocation, monitoring, prediction, communication, workflow coordination, eligibility determination, or decision support. The institution is not replaced by the model. Rules, authority, budgets, legal mandates, professional practices, data infrastructures, organizational routines, and appeal procedures remain part of the configuration. AI mediation can nevertheless change how those institutional elements operate and which positions become visible or influential.

Definition 23.294 (AI-mediated institution record). An *AI-mediated institution record* specifies the institutional function being mediated, the artificial system and version, the rules and objectives supplied to it, the data and classifications it uses, the human and organizational positions that authorize or rely on its outputs, the affected allocation or participation pathways, the audit and contestation channels, the economic incidence, and the legal, political, technical, or ethical questions requiring separate warrant.

The record treats institutional mediation as relational. A ranking system can alter resource allocation even where final decisions remain formally human. A recommendation system can reorganize attention and opportunity without possessing authority in a legal sense. A predictive system can change how staff allocate scrutiny, thereby changing the data later used to retrain the system. Institutions and AI systems can therefore co-produce trajectories through feedback.

Proposition 23.295 (Institutional-mediation non-equivalence). *The presence of AI mediation in an institutional process does not by itself establish transfer of institutional authority, legal responsibility, political legitimacy, or normative accountability to the artificial system; each transfer claim requires independent evidence about the relevant rule, practice, and domain-specific status.*

This proposition is especially important where organizations describe decisions as “automated.” Automation can redistribute practical control while formal authority remains elsewhere. GRE can analyze incidence, incentives, labor reorganization, access, dependency, and economic power. Legal and political inquiry can determine whether authority or responsibility has shifted under the relevant standards.

Definition 23.296 (Institutional AI feedback profile). An *institutional AI feedback profile* records how AI-mediated classifications or decisions alter later behavior, data generation, organizational routines, resource allocation, participation, and retraining or model-update conditions, including the mechanisms through which the institution and system become mutually conditioning over time.

23.12.8 Economic and Non-Economic AI Questions

The eighth interface makes question allocation explicit. AI-related research often combines technical, economic, epistemic, legal, political, educational, ethical, and ontological questions in one discussion. Their interaction is real, but interaction does

not erase disciplinary responsibility. A technically accurate model can be economically undesirable. An economically productive deployment can be legally invalid or politically illegitimate. A safe and profitable system can still raise unresolved questions about education, labor meaning, subjecthood, or moral standing. Conversely, a philosophically interesting question about artificial consciousness may have limited relevance to a specified economic mechanism.

Definition 23.297 (AI question-allocation record). An *AI question-allocation record* decomposes a research problem into technical, economic, epistemic, legal, political, educational, social, ethical, ontological, or other domain-specific subquestions; identifies the evidence and warrant required by each; records their dependencies; and specifies where joint inquiry, sequential handoff, or non-translation is required.

The record does not require every project to involve every domain. Its function is to prevent one domain from answering another domain's question by proxy. Market adoption cannot establish technical safety. Benchmark superiority cannot establish legal authority. Economic efficiency cannot establish justice. Human preference surveys cannot settle artificial consciousness. Likewise, the absence of a settled theory of consciousness need not prevent economic analysis of an AI-mediated workflow where the relevant incidence does not depend on that question.

Proposition 23.298 (Question-separation with dependency). *AI-related questions should remain separately warranted even when their answers are mutually conditioning; a downstream GRE claim may depend on a technical, legal, political, educational, ethical, or ontological premise, but that dependence should be recorded rather than converted into economic evidence for the premise itself.*

This principle supports efficient interdisciplinary inquiry. If an economic claim changes materially depending on whether a system is robust to adversarial inputs, the technical premise can be handed to AI evaluation. If a labor-incidence result changes depending on whether a worker has a legally protected right to explanation or appeal, the legal premise can be handed to GR-Law. If a participation claim depends on whether meaningful consent is possible under an institutional power structure, political or ethical inquiry may be required. The interface thereby converts interdisciplinarity from thematic breadth into a traceable dependency architecture.

Definition 23.299 (AI interface dependency graph). An *AI interface dependency graph* is a versioned representation of the cross-domain premises on which an AI-related GRE claim depends, the domain responsible for each premise, the evidential state of that premise, and the GRE conclusions that would require revision if the premise changes.

23.12.9 Limits of GRE Scope

The final interface concerns the limits of GRE scope. Artificial intelligence is economically consequential enough that economics cannot treat it as merely external technology. Yet economic relevance does not authorize GRE to become a general theory of AI. The strongest boundary discipline is therefore to state which conclusions GRE can support and which remain conditional on other domains.

Definition 23.300 (GRE AI-scope boundary). The *GRE AI-scope boundary* distinguishes claims concerning economic capability realization, allocation, value, production, labor, ownership, dependence, power conversion, participation, institutional mediation, and future economic options from claims concerning technical safety,

cognition, consciousness, subjecthood, moral standing, legal personality, political legitimacy, pedagogical adequacy, or other non-economic statuses whose warrant lies principally outside GRE.

The boundary is revisable rather than fixed. A new technical result can change what counts as substitutable capability. A new legal classification can change ownership, liability, or access. A political institution can alter authority over model deployment. Educational research can show that a productive AI workflow weakens or strengthens later human capability. Ethical or philosophical inquiry can alter the set of positions whose interests must be represented. Each correction can legitimately change GRE without requiring GRE to internalize the entire neighboring discipline.

Definition 23.301 (AI studies correction return). An *AI studies correction return* is a documented finding from technical, epistemic, legal, political, educational, social, ethical, philosophical, or other AI-related inquiry that requires GRE to revise an artificial-agency classification, subject architecture, capability comparison, epistemic-asymmetry claim, dependency model, participation assessment, institutional mechanism, value-incidence map, or domain boundary.

The correction return should also be bidirectional. GRE can show that a technically capable system is economically inaccessible, that formal choice coexists with deep dependency, that verification costs are unevenly distributed, that an institutional deployment changes participation or bargaining, or that ownership and infrastructure concentration alter who can benefit from technical progress. These are economic findings that neighboring AI research may need in order to characterize real-world deployment rather than isolated model behavior.

Proposition 23.302 (Economic-reduction limit for AI). *An AI-related conclusion exceeds GRE scope when its validity depends principally on a technical, epistemic, legal, political, educational, ethical, social, or ontological judgment that is neither supplied by GRE's economic evidence nor imported through an explicit and answerable interface.*

Definition 23.303 (GRE–AI studies interface portfolio). A *GRE–AI studies interface portfolio* is a versioned collection of artificial-agency profiles, subjecthood records, capability and epistemic interface profiles, dependence records, human-participation profiles, AI-mediated institution records, question-allocation records, cross-domain dependency graphs, correction returns, and unresolved scope questions across projects.

Proposition 23.304 (GRE–AI interface answerability). *A GRE–AI studies interface is answerable when the artificial configuration, technical capability premise, economic realization pathway, affected positions, dependency and participation structure, institutional mediation, cross-domain premises, scope boundary, and possible correction returns are explicit enough that contrary technical or neighboring-domain analysis can revise the GRE interpretation or reclassify the inquiry.*

This condition keeps artificial intelligence inside GRE where economic relations genuinely depend on it while preventing economic consequence from becoming a proxy for a general ontology or normativity of AI. GRE can investigate how artificial capabilities are financed, accessed, incorporated, concentrated, converted into power, distributed through institutions, and coupled to future economic possibility. AI studies and neighboring GR domains retain independent responsibility for technical characterization, epistemic warrant, legal and political status, educational consequence, ethical standing, subjecthood, and other claims whose validity cannot be derived from economic performance. The next interface turns from artificial systems

to social theory, where the principal boundary problem concerns institutions, culture, identity, social reproduction, collective meaning, and the extent to which economic relations remain embedded in wider social configurations.

23.13 Social Theory Interface

Chapter 2 reconstructed institutional economics, economic sociology, relational sociology, network analysis, and social field theory as intellectual resources for analyzing actors, institutions, positions, identities, and economic action through patterned relations rather than isolated attributes. Later chapters used some of those resources to develop GRE's accounts of economic subjecthood, value, power, participation, institutions, and generative capacity. The present section has a different role. It specifies the interface between GRE and social theory while preserving society as a wider field of inquiry than the economy. Its objective is to distinguish social relations that constitute economic positions, social mechanisms that mediate economic consequences, and social meanings or relations whose principal explanation remains social even when they affect production, exchange, allocation, valuation, or future economic possibility. The discussion develops nine interface domains: social relations, institutions, social fields, culture, identity, social reproduction, collective meaning, economic embeddedness, and social relational remainders. The method is relational and comparative. It uses the containment and translation disciplines established in Sections 23.2–23.3, while treating sociological concepts as independently warranted constructs rather than as undeclared extensions of GRE terminology.

Relational sociology provides especially important background for this interface because it directs analysis toward transactions, interdependencies, positions, and dynamic relations rather than assuming that socially relevant properties reside entirely within pre-given actors (Emirbayer 1997). Economic sociology adds the further observation that economic action remains embedded in ongoing social relations (Granovetter 1985). Neither commitment implies that every social relation is economic or that society can be reconstructed from economic variables. The interface therefore requires explicit typing of the relation under investigation and an account of how social constitution becomes economically consequential.

Definition 23.305 (GRE–social theory interface record). A *GRE–social theory interface record* specifies the social relation, institution, field, cultural formation, identity process, reproductive arrangement, or collective meaning under investigation; the economic positions and processes it conditions; the pathway through which the social object becomes economically consequential; the aspects whose explanation remains principally social-theoretical; the evidence required by each domain; and the GRE claims that would require revision if the social-theoretical characterization changes.

The record prevents “society” from becoming an undifferentiated background variable. A household norm, professional identity, religious practice, organizational field, neighborhood network, kinship relation, status hierarchy, or shared classification can enter an economic process through different mechanisms. Some affect access, bargaining, trust, valuation, labor supply, credit, care, recognition, or institutional legitimacy. Others may remain economically peripheral in the inquiry even while being socially central to the people involved.

Proposition 23.306 (Social-theory handoff condition). A *GRE inquiry should hand a*

Table 23.13: Principal operations at the GRE–social theory interface

Interface object	GRE question	Social-theory question	Possible correction to GRE
Social relations	How does a relation alter access, allocation, bargaining, value, capability, or economic options?	What kind of social relation exists, how is it constituted, and what meanings or obligations organize it?	Revised relation type, actor boundary, or causal pathway
Institutions	How do institutional arrangements shape economic coordination and incidence?	How are rules, norms, legitimacy, roles, practices, and organizational forms reproduced?	Revised institutional mechanism or effective rule set
Social fields	How does position affect economic possibility or conversion?	What defines the field, its stakes, positions, boundaries, and recognized resources?	Revised field boundary, position map, or resource interpretation
Culture	How do cultural classifications or practices affect valuation and economic conduct?	How are meanings, repertoires, distinctions, and practices produced and sustained?	Revised valuation, preference, legitimacy, or participation account
Identity	How does identity condition opportunity, treatment, capability, or economic role?	How is the identity assigned, claimed, recognized, contested, or transformed?	Revised subject classification and heterogeneous-position model
Social reproduction	Which background processes sustain people, capabilities, institutions, and economic participation?	How are care, household, kinship, community, and reproductive relations organized and valued?	Revised reproduction cost, capability, and sustainability analysis
Collective meaning	How does shared interpretation affect coordination, trust, valuation, or institutional efficacy?	How is meaning collectively generated, stabilized, disputed, and changed?	Revised interpretation of signals, categories, or institutional effects
Economic embeddedness	Which social dependencies materially condition an economic mechanism?	Which networks, institutions, norms, and meanings constitute the surrounding social configuration?	Revised boundary and mechanism specification
Social relational remainders	Which economic consequences arise from a relation whose principal meaning remains social?	What social goods, obligations, identities, or meanings would be lost through economic reduction?	Explicit non-economic remainder and narrowed GRE claim

material subquestion to social theory when its resolution depends principally on the constitution, meaning, reproduction, classification, identity, legitimacy, or relational organization of social life and cannot be established from economic incidence, incentives, allocation, value conversion, or economic power alone.

The handoff remains reciprocal. Social theory can show that GRE has misidentified an actor, boundary, institution, field, category, or reproductive process. GRE can show that a social configuration has economically unequal incidence, that access to a socially valued position depends on material resources, that institutional legitimacy is coupled to distributive consequences, or that a social practice changes later capability and option structure. Table 23.13 summarizes the principal interface operations developed below.

23.13.1 Social Relations

The first interface concerns the relation itself. Social theory contains several non-equivalent concepts of relation: interaction, exchange, interdependence, tie, transaction, membership, role relation, status relation, constitutive dependence, and position within a wider configuration. Simmel's analysis of forms of interaction, Elias's figurational account of interdependence, and later relational sociology all show that socially consequential properties can depend on relations among persons and collectivities rather than on isolated attributes alone (Simmel 1971; Elias 1978; Emirbayer

1997). GRE can inherit this relational attentiveness, but it needs a further question: when does a socially constituted relation become relevant to an economic explanation?

Economic relevance can arise through several pathways. A friendship relation may transmit job information. A kinship relation may organize care, inheritance, credit, or migration. A professional relation may confer reputation or access. A status relation may influence wages or bargaining. A neighborhood relation may organize mutual aid. None of these examples makes friendship, kinship, profession, status, or neighborhood reducible to an economic relation. The economic question concerns a specified consequence or conversion pathway within a socially richer relation.

Definition 23.307 (Social-to-economic relevance pathway). *A social-to-economic relevance pathway identifies a socially constituted relation and the mechanism through which that relation changes an economically relevant position, including access, information, obligation, trust, bargaining, valuation, capability, resource flow, institutional treatment, or feasible future options.*

The pathway is narrower than a claim that the social relation exists for economic purposes. It permits GRE to analyze economic effects while retaining the relation's wider social constitution. This distinction is particularly important for relations whose participants understand them through care, loyalty, belonging, ritual, status, friendship, kinship, vocation, or civic obligation rather than through exchange value.

Proposition 23.308 (Relation-typing condition). *A socially observed relation should enter GRE as an economic relation only when the economic dimension is part of the relation's declared analytical type; otherwise GRE should represent the relation as a social condition, mediator, or source of economic consequence whose wider constitution remains outside the economic classification.*

This condition prevents analytical convenience from silently changing the object. A parent-child relation can contain transfers of money, time, care, and future opportunity while remaining more than a transfer relation. A friendship can support entrepreneurial coordination without becoming equivalent to a commercial partnership. Conversely, a formally economic contract can generate social ties and identities that later affect conduct beyond the contract. The interface therefore permits relations to be multiply consequential without requiring one disciplinary type to exhaust their meaning.

23.13.2 Social Institutions

Institutions form the second interface because GRE frequently analyzes rules, organizations, property structures, markets, firms, public agencies, and governance arrangements. Social theory broadens the institutional object beyond a set of incentive constraints. Institutions can include formal rules, informal norms, legitimate expectations, role classifications, routines, organizational forms, professional standards, and practices through which participants understand what conduct is possible or appropriate. Polanyi's account of the economy as an instituted process and sociological institutionalism's attention to legitimacy and organizational fields both demonstrate that economic coordination is socially organized in ways that exceed a purely parametric environment (Polanyi 1957; DiMaggio and Powell 1983).

GRE needs this broader institutional description because a rule's written form may differ from its practical operation. Access can depend on informal gatekeeping. A

nominal right can be difficult to exercise. A professional norm can alter adoption even without legal compulsion. Organizational imitation can spread a practice before its efficiency is known. Institutional analysis must therefore distinguish the formal rule, enacted practice, legitimacy structure, enforcement relation, organizational carrier, and economic effect.

Definition 23.309 (Institutional interface profile). An *institutional interface profile* records the formal rules, informal norms, roles, organizational carriers, legitimacy claims, enforcement or sanction practices, recurrent routines, affected positions, and economic mechanisms associated with an institution, together with discrepancies between formal design and enacted operation.

The profile is useful when GRE investigates institutions as generative economic infrastructure. A labor-market credential, for example, can influence access to employment through formal qualification rules, professional expectations, reputational meaning, organizational screening, and network recognition. Treating the credential only as information about productivity may omit the social processes that make it authoritative.

Proposition 23.310 (Institutional-description non-equivalence). An *institution's economic effect, formal rule, enacted practice, and social legitimacy are distinct descriptions; evidence for one does not by itself establish the others.*

The distinction creates a direct correction channel. If social research shows that an apparently universal rule is interpreted differently across groups, GRE should revise its effective institutional architecture. If an organizational form is reproduced through legitimacy or professional convention rather than the efficiency mechanism assumed by an economic model, the causal interpretation should change. Law and governance may provide additional domain-specific corrections where formal authority, rights, duties, or public decision are material, as developed in Sections 23.8–23.9.

23.13.3 Social Fields

The third interface concerns social fields. Field language is especially sensitive because GRE also uses field-oriented descriptions for distributed relational conditions and, in some chapters, cautiously employs field-theoretic formalisms. Social field theory has its own intellectual history and should not be treated as interchangeable with those analytical devices. Bourdieuan field theory links positions, forms of capital, habitus, stakes, and symbolic power; other field approaches emphasize relative position, social skill, incumbency, challenge, governance units, or inter-field dependence (Bourdieu and Wacquant 1992; Martin 2003; Fligstein and McAdam 2012). These are sociological theories with domain-specific commitments, not generic synonyms for any relational configuration.

GRE can nevertheless benefit from field analysis when economic possibility depends on position inside a socially structured arena. Access to a profession, the convertibility of credentials, the legitimacy of a business practice, the prestige of an occupation, or the capacity to mobilize social capital can vary by field. The economic value of a resource may therefore depend on a social structure that defines where, by whom, and under which classifications that resource is recognized.

Definition 23.311 (Social-field translation record). A *social-field translation record* identifies the source field concept, its actors or positions, stakes, recognized resources,

boundary criteria, mechanisms of reproduction or change, and the specific economic question for which a translated representation is proposed; it also records which field-theoretical meanings are lost, transformed, or retained in the GRE use.

This record is necessary because similar vocabulary can conceal different objects. A “field” in Bourdieuan sociology, a strategic action field, a physical field, and a GRE relational field can all describe distributed or positional structure while differing in ontology, measurement, mechanism, and explanatory purpose.

Proposition 23.312 (Field-vocabulary non-equivalence). *Shared use of the term field does not establish theoretical equivalence among social field theory, formal field representations, and GRE relational-field language; translation requires an explicit mapping of positions, variables, mechanisms, and interpretive commitments.*

The proposition protects both sides of the interface. GRE should not redescribe a sociological field as a mathematical field merely because formalization is convenient. Social theory should likewise be able to show that the economically relevant boundary or position assumed by GRE fails to capture the field as socially organized. Field structure becomes an interface object precisely because its economic and social descriptions may overlap without coinciding.

23.13.4 Culture

Culture forms the fourth interface. In economic inquiry, culture is sometimes introduced as a residual explanation for differences left unexplained by prices, institutions, or individual attributes. Such usage is too coarse for an answerable interface. Cultural formations can include shared classifications, evaluative repertoires, narratives, symbolic distinctions, rituals, practical habits, styles of interpretation, and historically transmitted expectations. Their economic relevance depends on a specific mechanism rather than on the generic assertion that “culture matters.”

Culture can affect valuation, consumption, saving, work, entrepreneurship, cooperation, status competition, trust, legitimacy, organizational practice, and the interpretation of economic signals. Yet the economic consequence is only one dimension of the cultural object. A ritual may influence expenditure while its principal meaning concerns belonging. A professional ethos may affect labor supply while also organizing vocation and dignity. A cultural classification may influence prices while simultaneously structuring status or identity.

Definition 23.313 (Cultural mediation profile). *A cultural mediation profile records the cultural classification, narrative, repertoire, norm, practice, or symbolic distinction under investigation; the actors or collectivities for whom it is meaningful; the historical and institutional setting of its reproduction; the economic behavior or relation it conditions; and the evidence connecting the cultural formation to that economic consequence.*

The profile requires more than correlation between group membership and an economic outcome. It asks how the relevant meaning or practice is produced, recognized, enacted, and translated into an economically consequential mechanism.

Proposition 23.314 (Cultural-conversion condition). *A cultural difference becomes a GRE explanatory object when a defensible pathway links the cultural formation to an economic relation, valuation, allocation, capability, constraint, participation pattern, or future option; the pathway does not exhaust the cultural formation’s social meaning.*

This condition also makes correction possible. If ethnographic, historical, or sociological evidence shows that the meaning assigned by the economic model is mistaken, the GRE mechanism should be revised even where the statistical association remains. Cultural interpretation is therefore neither decorative context nor a license for unmeasured explanation. It is an independently answerable component of the interface.

23.13.5 Identity

Identity forms the fifth interface because economic positions are often organized through categories that people claim, receive, negotiate, contest, or have institutionally assigned to them. Social theory cautions against treating identity as a fixed attribute whose meaning is stable across settings. Network and relational accounts show that identities can emerge and change through social formations, interaction, control efforts, stories, and positions (White 2008). GRE therefore needs to distinguish an identity category used in data, an identity recognized by an institution, an identity experienced or claimed by a participant, and an economic role associated with that identity.

The economic relevance of identity can arise through differential treatment, network access, occupational sorting, consumption, political or organizational recognition, credentialing, discrimination, trust, care obligations, or the distribution of unpaid work. The same category can have different effects across institutions and historical periods. Conversely, people occupying similar economic positions can understand those positions through different identities and social meanings.

Definition 23.315 (Identity–economic interface record). *An identity–economic interface record specifies the identity category or process under investigation, the mode of assignment or recognition, the relevant social setting, the economic position or mechanism with which it interacts, the evidence for that interaction, and the aspects of identity whose meaning cannot be inferred from the economic role alone.*

The record prevents administrative categories from being treated as complete social subjects. It also permits identity to be endogenous to economic relations where appropriate. Occupational classifications, class positions, consumer identities, entrepreneurial identities, and organizational roles can be partly generated through economic participation, while retaining cultural, political, familial, or status dimensions that require wider social analysis.

Proposition 23.316 (Identity-role non-equivalence). *An economic role and a social identity may mutually condition one another, but neither should be inferred as a complete representation of the other without evidence concerning recognition, meaning, institutional classification, and historical formation.*

This distinction matters for GRE's heterogeneous-subject architecture. Heterogeneity should not be represented only by scalar differences in resources or capabilities. Socially constituted identities can affect which resources are recognized, which actions are available, which obligations are expected, and which outcomes are experienced as losses or gains. Social theory can therefore return corrections to the very specification of the economic subject.

23.13.6 Social Reproduction

Social reproduction forms the sixth interface because economic activity depends on processes that sustain people, households, communities, institutions, skills, norms, and future generations. Feminist economics and social-reproduction scholarship have long emphasized the economic significance of unpaid care, household labor, childrearing, and other background activities that standard market accounts can understate or omit (Folbre 1994; Fraser 2014). GRE's concern with generative capacity makes these processes especially important, but the conceptual overlap should not be treated as identity.

The term *social reproduction* itself carries several meanings. It can refer to daily and intergenerational reproduction of people and labor capacities; to care and household provisioning; to reproduction of institutions, inequalities, status relations, or cultural forms; or to the persistence of a wider social order. A GRE analysis should declare which meaning is operative before relating reproduction to economic generativity.

Definition 23.317 (Social-reproduction interface profile). *A social-reproduction interface profile records the persons, relations, activities, institutions, infrastructures, and temporal horizons through which a specified social capacity or social order is sustained; the distribution of material, temporal, emotional, and organizational burdens; the economic processes that depend on the reproduced capacity; and the social values or obligations that remain irreducible to the economic use of that capacity.*

The profile makes visible a common asymmetry: an economic process can draw on reproduced capacities without fully financing, recognizing, or sustaining the relations that generate them. Care, education, public health, community trust, household coordination, and intergenerational support can therefore function as enabling conditions whose depletion appears only later as reduced capability, higher replacement cost, lower participation, or institutional fragility.

Proposition 23.318 (Reproductive-condition endogeneity). *When an economic process materially depends on a socially reproduced capacity and also changes the conditions through which that capacity is reproduced, the reproductive process should be represented as endogenous to the economic analysis rather than as a fixed external background.*

Endogeneity does not imply economic ownership of the object. A caregiving relation can matter to labor-market participation while possessing meanings and obligations that cannot be evaluated through labor supply alone. Social reproduction therefore supplies a particularly clear example of reciprocal correction: social theory broadens GRE's account of the conditions of economic possibility, while GRE can analyze how allocation, compensation, ownership, public provision, and power affect the sustainability of those conditions.

23.13.7 Collective Meaning

Collective meaning forms the seventh interface. Economic coordination relies extensively on categories, expectations, narratives, classifications, symbols, and shared interpretations. Money, credentials, brands, professions, organizational offices, property categories, market conventions, and institutional procedures function partly because participants recognize and act through socially stabilized meanings.

GRE's relational-reality architecture can accommodate the causal efficacy of such socially sustained configurations without claiming that shared meaning is reducible to individual belief or that every collectively recognized object is economic.

A meaning can be shared unevenly, contested, institutionally enforced, or differently interpreted across positions. The same symbol can carry distinct meanings for workers, managers, regulators, consumers, or communities. Collective meaning therefore cannot be inferred merely from behavioral regularity. Repeated conduct may arise from coercion, habit, convention, shared interpretation, strategic compliance, or several mechanisms at once.

Definition 23.319 (Collective-meaning interface record). *A collective-meaning interface record identifies the category, symbol, narrative, classification, or interpretive convention under investigation; the community or positions among which it is recognized; the practices and institutions through which it is sustained; the degree and form of contestation; and the economic mechanism whose operation depends on that meaning.*

The record can be used, for example, when the economic efficacy of a credential depends on social recognition, when a product category organizes valuation, when a narrative changes investment behavior, or when a status distinction shapes occupational choice. The relevant economic claim concerns the consequence of meaning; the social-theoretical claim concerns how that meaning is produced, distributed, and transformed.

Proposition 23.320 (Semantic-to-economic conversion condition). *A collectively sustained meaning enters a GRE mechanism when changes in its recognition or interpretation can alter an economically relevant relation, valuation, access condition, institutional practice, capability, or feasible option through an identifiable pathway.*

This proposition creates an empirical vulnerability. If meaning changes while the proposed economic effect does not, or if the effect persists through a different mechanism, the GRE interpretation requires revision. Collective meaning is therefore neither an all-purpose explanation nor a merely subjective residue; it is a social object whose economic consequences must be traced.

23.13.8 Economic Embeddedness

Economic embeddedness is the eighth interface and provides the most direct bridge between economic sociology and GRE. Granovetter's critique of atomized economic action emphasizes that economic conduct is embedded in ongoing social relations, while Polanyi's substantive approach treats the economy as an instituted process organized through historically variable forms of integration (Granovetter 1985; Polanyi 1957). For GRE, the key implication is methodological: an economic mechanism should include the social dependencies that materially constitute its operation when excluding them would change the explanation.

Embeddedness should remain a discriminating concept rather than a statement that everything is connected to everything else. The relevant question is which social relation, institution, meaning, identity, or reproductive process changes the economic mechanism under study. An entrepreneur's access to finance may depend on networks. A market's operation may depend on legal and cultural classifications. A firm's labor process may depend on household care arrangements. A platform market may depend on status, community norms, or trust. Different forms of embeddedness

therefore require different evidence.

Definition 23.321 (Economic-embeddedness interface record). *An economic-embeddedness interface record specifies the focal economic process, the social relations or formations on which its operation materially depends, the mechanisms of dependence, the relevant boundary and timescale, the evidence that the social configuration changes the economic process, and the social-theoretical questions that remain independently open.*

The record also guards against the opposite error of treating every social relation surrounding an economic activity as causally necessary. Social context may be descriptively present without carrying explanatory weight for the focal economic question. Embeddedness becomes analytically useful when removing, changing, or reclassifying the social condition would alter the economic mechanism or its expected consequences.

Proposition 23.322 (Embeddedness answerability). *An embeddedness claim is answerable when the focal economic mechanism, the relevant social configuration, the pathway of dependence, and the counterfactual or comparative basis for judging material influence are explicit enough that social or economic evidence can weaken, revise, or reject the claimed dependence.*

This answerability requirement preserves disciplinary containment. GRE can investigate the economic consequences of embedded social relations while social theory retains responsibility for the constitution and meaning of those relations. The interface is strongest when the two descriptions are mutually revisable rather than when one is treated as contextual decoration for the other.

23.13.9 Social Relational Remainders

The final interface concerns social relations whose principal meaning and organization remain outside GRE even when economic consequences are present. Family relations, friendship, intimacy, ritual, religious community, civic association, status, solidarity, mourning, celebration, care, and forms of belonging can involve resources, labor, property, time, reciprocity, or economic inequality. Their economic dimensions can be legitimate GRE objects. Their social constitution, however, cannot be inferred from those dimensions alone.

The boundary matters because economic effects are pervasive. A friendship can affect employment; a religious community can organize mutual aid; a family can allocate assets; a civic association can influence local investment; a ritual can generate expenditure. If economic consequence were sufficient to classify the underlying relation as economic, GRE's domain would expand until almost every social relation became an economic relation. Such expansion would weaken rather than strengthen the research programme because the principal problem-space would cease to constrain explanation.

Definition 23.323 (Social relational remainder). *A social relational remainder is the set of constitutive meanings, obligations, identities, practices, affective relations, status structures, or collective purposes of a socially organized relation that remain analytically material after its economic consequences have been represented and that cannot be warranted from the economic representation alone.*

The remainder does not mean that social theory possesses an immutable jurisdic-

tion over a fixed object. Domain boundaries remain revisable. It means that GRE should preserve the unresolved social content explicitly rather than translating it into utility, resource flow, preference, price, capability, or economic value without justification.

Definition 23.324 (Social-theory correction return). *A social-theory correction return* is a documented social-theoretical finding that requires GRE to revise a relation type, subject boundary, institutional mechanism, field boundary, cultural interpretation, identity classification, reproductive dependency, collective-meaning claim, embeddedness pathway, or domain boundary.

Correction can also move in the other direction. GRE may reveal that a socially valued institution systematically redistributes risk, that a status order controls material access, that a cultural practice depends on uncompensated labor, that a reproductive arrangement narrows future capability, or that an apparently voluntary relation is sustained by economic dependency. These economic findings can become inputs to social theory without claiming to settle the relation's wider meaning or legitimacy.

Definition 23.325 (GRE–social theory interface portfolio). *A GRE–social theory interface portfolio* is a versioned collection of social-to-economic relevance pathways, institutional profiles, social-field translation records, cultural mediation profiles, identity interface records, social-reproduction profiles, collective-meaning records, embeddedness records, social relational remainders, and correction returns across projects.

Proposition 23.326 (GRE–social theory interface answerability). *A GRE–social theory interface is answerable when the social object, economic mechanism, translation pathway, retained social remainder, evidence, boundary, and possible correction returns are explicit enough that contrary social-theoretical or economic analysis can revise the interpretation, change the domain allocation, or withdraw the claimed economic mechanism.*

The interface thereby preserves a demanding form of embedded economic analysis. GRE can study how economic relations are socially constituted, how institutions and fields organize economic possibility, how culture and identity mediate valuation and access, how social reproduction sustains capacities, and how collective meanings stabilize or transform economic coordination. Social theory retains independent responsibility for the constitution and interpretation of social relations whose meaning exceeds their economic incidence. The resulting relation is one of reciprocal correction rather than disciplinary absorption. Section 539 turns to aesthetics, where salience, orientation, judgment, curiosity, and value formation create a different interface between economically consequential processes and a domain whose objects cannot be reconstructed from economic value alone.

23.14 Aesthetics Interface

Aesthetic judgment has already appeared at several points in the book without being treated as an economic synonym for preference. Chapter 6 distinguished salience, significance, judgment, orientation, and aesthetic conditions within research and application praxis. Chapter 17 then examined aesthetic judgment as a source of epistemic orientation under conditions in which inquiry possibilities exceed available attention and resources. Section 23.10 extended that architecture to education, where aesthetic judgment can help learners orient among examples, explanations, forms, and possi-

ble questions without independently establishing educational quality or truth. The present section has a wider role. It specifies the interface between GRE and aesthetics while preserving aesthetic experience, judgment, value, and practice as domains whose significance is not exhausted by economic incidence. Its objective is to identify how aesthetic judgment can become economically consequential through salience, orientation, curiosity, valuation, production, consumption, participation, and institutional selection; how economic conditions can widen or narrow aesthetic possibility; and where economic translation leaves a domain-specific remainder. The discussion proceeds through eight interfaces: aesthetic judgment, salience, orientation, curiosity, value formation, economic conditions of aesthetic possibility, the relation between aesthetic and economic value, and the limits of economic translation. The method is relational and comparative. It uses the containment and translation disciplines established in Sections 23.2–23.3 while preserving the distinction between an economic consequence of aesthetic judgment and the aesthetic constitution of the judgment itself.

The interface requires restraint because aesthetic traditions do not supply one settled object that GRE can simply import. Kant's account of judgments of taste, Hume's account of cultivated judgment, Dewey's account of aesthetic experience, and Bourdieu's sociology of taste offer materially different descriptions of judgment, experience, cultivation, and social formation (Kant 1987; Hume 1985; Dewey 1934; Bourdieu 1984). Their non-equivalence is analytically useful. It prevents GRE from assuming that aesthetic value is merely subjective preference, social distinction, formal beauty, pleasurable response, or market willingness to pay. GRE instead asks a narrower economic question: through which relations do aesthetically organized experiences and judgments change attention, allocation, participation, capability, valuation, institutional practice, or future possibility, and through which economic conditions are those experiences and judgments themselves enabled or constrained?

Definition 23.327 (GRE–aesthetics interface record). *A GRE–aesthetics interface record specifies the aesthetic object, experience, practice, judgment, or evaluative relation under investigation; the positions and communities within which it is formed; the historically relevant standards, repertoires, or fields of comparison; the economic conditions that enable or constrain its formation and exercise; the pathway through which it becomes economically consequential; the aesthetic questions that remain independently open; and the GRE claims that would require revision if the aesthetic characterization changes.*

The record is deliberately broader than a consumer-preference profile. It can apply to artistic production, design, architecture, scientific representation, education, public space, craft, interface design, organizational form, cultural participation, landscape experience, or everyday practices in which qualities such as coherence, fittingness, contrast, elegance, rhythm, surprise, depth, atmosphere, or expressive force become consequential. Some of these qualities can affect price or demand. Others can affect attention, trust, participation, learning, preservation, care, identity, or willingness to remain within a practice without ever becoming adequately represented by price.

Proposition 23.328 (Aesthetic handoff condition). *A GRE inquiry should hand a material subquestion to aesthetics or a relevant neighboring discipline when its resolution depends principally on the constitution, experience, interpretation, cultivation, comparison, or domain-specific value of an aesthetic judgment and cannot be established from*

Table 23.14: Principal operations at the GRE–aesthetics interface

Interface object	GRE question	Aesthetic question	Possible correction to GRE
Aesthetic judgment	How does judgment alter attention, selection, participation, valuation, or economic action?	What is being judged, through which standards, experiences, practices, or comparisons, and with what domain-specific significance?	Revised judgment type, preference interpretation, or causal pathway
Salience	Which formal or experiential qualities become prominent enough to attract scarce attention?	Why does the object become perceptually, affectively, or interpretively salient within the relevant field?	Revised attention mechanism or prominence measure
Orientation	How does aesthetic judgment direct commitment among alternatives under incomplete information?	How is orientation cultivated, exercised, contested, and revised within the practice?	Revised selection or persistence mechanism
Curiosity	Which aesthetic encounters open further exploration, question formation, or participation?	How do surprise, beauty, unfamiliarity, tension, or form generate or inhibit curiosity?	Revised account of demand, motivation, or option formation
Value formation	How do aesthetic judgments enter demand, reputation, symbolic differentiation, identity, or resource allocation?	How is aesthetic value formed, learned, disputed, and sustained within a field or community?	Revised valuation, preference, or status mechanism
Aesthetic possibility	Which economic conditions widen or narrow access to aesthetic experience, production, judgment, and participation?	Which practices, capacities, environments, and relations make aesthetic experience or creation possible?	Revised resource boundary or capability analysis
Aesthetic and economic value	Where do aesthetic evaluation and economic valuation interact without becoming identical?	What gives the object aesthetic worth within the relevant practice or experience?	Explicit value plurality and limited commensuration
Translation limits	Which economic consequences can be represented without absorbing the aesthetic object?	Which meanings, experiences, standards, or values remain irreducibly aesthetic for the inquiry?	Narrowed GRE claim and explicit aesthetic remainder

economic preference, demand, price, allocation, capability, or institutional incidence alone.

The handoff remains reciprocal. Aesthetic inquiry can show that GRE has mischaracterized the object of judgment, confused popularity with quality, treated learned taste as a fixed preference, or ignored the experiential organization through which an intervention becomes attractive, alienating, legible, coherent, or oppressive. GRE can in turn identify material inequalities in exposure, time, training, production resources, cultural infrastructure, distribution channels, and institutional recognition that condition which aesthetic possibilities can be encountered, cultivated, expressed, or sustained. Table 23.14 summarizes the principal interface operations developed below.

23.14.1 Aesthetic Judgment

Aesthetic judgment is the first interface because economic analysis often encounters its effects before it possesses an adequate account of its constitution. Consumers choose among designs, audiences allocate attention, researchers prefer some representations, communities protect some landscapes, organizations adopt particular forms, and institutions recognize some works or practices as worthy of preservation. These decisions can have prices, budgets, labor requirements, distributional consequences, and long-term effects. Yet the existence of an economic consequence does

not show that the judgment was economically constituted or that its significance can be recovered from the observed choice.

The philosophical diversity already noted is instructive. Kant does not treat a judgment of taste as an ordinary judgment of utility; Hume treats cultivated taste as involving practice, comparison, delicacy, and freedom from prejudice; Dewey locates aesthetic experience within temporally organized interaction between organism and environment; Bourdieu emphasizes the social formation of taste and its relation to classed dispositions and distinction (Kant 1987; Hume 1985; Dewey 1934; Bourdieu 1984). GRE need not adjudicate among these accounts in order to preserve a basic interface discipline: observed economic behavior does not uniquely identify the aesthetic judgment that helped produce it.

Definition 23.329 (Aesthetic-judgment interface profile). *An aesthetic-judgment interface profile records the object or experience judged, the relevant qualities and comparison field, the judging position or community, the practices and histories through which standards of judgment were formed, the degree of agreement or contestation, the economic consequences associated with the judgment, and the evidential boundary between those consequences and the aesthetic significance of the judgment itself.*

The profile prevents a recurrent reduction. A high price may indicate scarcity, status competition, speculative expectation, institutional recognition, purchasing power, provenance, or a conjunction of these mechanisms. It cannot by itself establish aesthetic worth. Low market demand likewise cannot establish aesthetic failure. A work can be aesthetically important within a small community; a public space can possess qualities that are weakly monetized; a craft practice can be aesthetically rich while economically precarious; an aesthetically compelling product can succeed commercially for reasons unrelated to the judgment that specialists would regard as aesthetically relevant.

Aesthetic judgment can also have economic effects without being fully verbalized. Experienced practitioners often possess forms of taste that operate through comparison, sensitivity to proportion, rhythm, texture, fit, coherence, tension, or expressive force before they can state an explicit rule. Chapter 6 treated practical taste as historically formed and potentially expertise-bearing while remaining open to inherited exclusion. The same discipline applies here. Tacit judgment can carry information while also reproducing conventions, status hierarchies, and path-dependent standards.

Proposition 23.330 (Judgment-price non-equivalence). *Market price, observed demand, institutional prestige, popularity, and stated willingness to pay can provide evidence about the economic incidence of aesthetic judgment, but none should be treated as a general measure of aesthetic value without an independently warranted translation for the relevant domain and question.*

The proposition leaves room for empirical relations. Aesthetic evaluation can influence demand, and prices can influence later perceptions of quality. Institutional recognition can change exposure, while exposure can change familiarity and taste. The interface therefore studies reciprocal conditioning rather than requiring causal purity. What remains prohibited is the silent replacement of one evaluative domain by another.

23.14.2 Salience

Salience is the second interface because aesthetic qualities can make some objects, relations, or possibilities stand out within fields of abundance. Chapter 6 defined research salience as selective prominence before significance is established, and Chapter 17 extended that distinction to epistemic abundance. The aesthetics interface generalizes the problem beyond inquiry. A form, contrast, rhythm, atmosphere, arrangement, sound, image, phrase, or spatial organization can attract or hold attention before its wider practical, economic, epistemic, or normative significance is known.

Aesthetic salience is relational. What stands out depends on a background, expectation, repertoire, environment, and perceiving position. A minimalist form can be salient within visual density; an irregularity can be salient within a strongly patterned field; a quiet space can become salient within sensory overload; a traditional craft can become salient after industrial standardization; an unfamiliar style can become salient because it disrupts a learned expectation. Salience therefore cannot be represented adequately as an intrinsic amount of attractiveness attached to the object independently of context.

Definition 23.331 (Aesthetic-salience pathway). An *aesthetic-salience pathway* identifies the object or relation that becomes prominent, the perceptual or interpretive field against which prominence arises, the aesthetic qualities involved, the positions for which the salience occurs, the institutions or technologies that amplify or suppress it, and the economic consequences that follow from the resulting allocation of attention.

The institutional component is important. Platforms, advertising systems, exhibition spaces, publishing channels, architecture, urban design, retail environments, recommendation systems, and professional gatekeeping can all organize what becomes visible or memorable. Some mechanisms intensify aesthetically salient features because they increase engagement. Others standardize form in ways that reduce exposure to unfamiliar possibilities. Economic organization therefore participates in the production of salience, not only in the monetization of already salient objects.

Salience also creates a selection hazard. What is striking can receive disproportionate resources even when less salient objects have greater long-term value. A visually dramatic infrastructure project may attract political investment while maintenance remains aesthetically inconspicuous. A memorable interface can draw use even when its underlying arrangement produces dependency or surveillance. A fashionable research representation can attract attention before its explanatory adequacy is established. These cases parallel the warning developed earlier in the book: salience can open inquiry or participation, but it should not certify significance.

Proposition 23.332 (Aesthetic-salience non-certification). *Aesthetic salience can alter the probability that an object receives attention, participation, preservation, investment, purchase, or further inquiry while leaving its aesthetic quality, economic value, epistemic significance, and normative desirability separately unresolved.*

This distinction is especially important under conditions of symbolic abundance. When images, designs, texts, performances, and generated artifacts multiply faster than attention, selection mechanisms acquire increasing economic power. An aesthetics interface can then identify which forms receive visibility without treating visibility itself as evidence that the selected forms are aesthetically superior.

23.14.3 Orientation

Orientation is the third interface. Salience describes prominence; orientation concerns the more durable direction of attention, commitment, practice, or resource allocation among alternatives. Chapter 6 treated research orientation as a provisionally stabilized configuration of judgments, commitments, attention, questions, and resources. Aesthetic judgment can play a similar orienting role in artistic practice, design, consumption, education, scientific representation, public-space formation, craft, and ordinary life.

Orientation matters economically because action often precedes complete information. A designer chooses among forms before later user response is known. A researcher commits time to a representation whose explanatory fertility remains uncertain. A publisher invests in a work before demand is established. A city preserves a building or landscape before every future use can be specified. A student pursues a field partly because certain forms of thought or expression appear compelling. In each case, aesthetic judgment can help direct commitment under uncertainty.

Definition 23.333 (Aesthetic orientation). *Aesthetic orientation* is the historically and relationally formed use of form-sensitive, experiential, or taste-based judgment to direct attention, selection, persistence, representation, or practical commitment among alternatives whose wider significance or future consequences remain incompletely determined.

Definition 23.333 extends the narrower epistemic use developed in Chapter 17. The extension is not an assertion that all orientation is aesthetic. Institutional rules, moral commitments, prices, urgency, habit, coercion, professional standards, and strategic considerations can all orient action. The aesthetic interface asks when a form-sensitive judgment materially participates in that configuration and how its influence interacts with other judgment forms.

Orientation can be generative. A compelling form can lead a person into a practice, preserve persistence through uncertainty, or make a previously unnoticed relation worth exploring. It can also become conservative. Institutions can reproduce a narrow aesthetic canon, organizations can reward familiar forms, and professional fields can treat historically specific conventions as natural standards. Bourdieu's account of socially formed taste and McAllister's analysis of changing scientific aesthetic criteria both caution against treating aesthetic orientation as historically invariant (Bourdieu 1984; McAllister 1996).

Proposition 23.334 (Aesthetic-orientation revisability). *Where aesthetic judgment materially directs economic or practical commitment, the resulting orientation should remain revisable by later experience, evidence, changed relations, alternative aesthetic traditions, and relevant normative or institutional considerations rather than being treated as self-validating because it initially appeared fitting or beautiful.*

The proposition does not subordinate aesthetics to economics or epistemology. It preserves a more general principle of domain coexistence. Aesthetic orientation can legitimately matter while remaining one judgment relation among several in a complex praxis.

23.14.4 Curiosity

Curiosity is the fourth interface because aesthetic experience can open further exploration without first appearing as demand for a determinate good. Chapter 17 and Section 23.10 treated curiosity as a generative stage in inquiry and education. The aesthetics interface asks more broadly how beauty, surprise, unfamiliarity, tension, ambiguity, craftsmanship, atmosphere, expressive force, or formal relation can provoke the desire to look again, compare, learn, enter a practice, or discover what an object can become.

This relation should not be overstated. Curiosity can arise from danger, practical need, contradiction, moral concern, social interaction, or explicit problem solving without an aesthetic component. Conversely, an aesthetic experience can remain contemplative without producing further inquiry. The interface concerns cases in which aesthetic experience materially enlarges the horizon of possible engagement.

Definition 23.335 (Aesthetic-curiosity interface profile). An *aesthetic-curiosity interface profile* records the encounter that attracts further exploration, the aesthetic qualities through which the encounter becomes inviting or puzzling, the prior repertoire and expectations of the position encountering it, the opportunities and costs of continued exploration, the practices or communities capable of sustaining curiosity, and the later economic or non-economic consequences of the resulting inquiry or participation.

The economic component often lies in whether curiosity can continue. Time, security, access, mobility, materials, mentorship, tools, public institutions, and freedom from immediate pressure affect whether a compelling encounter becomes sustained exploration or disappears as an unrealized possibility. Veblen's discussion of "idle curiosity" remains relevant because it identifies a form of inquiry not exhausted by immediate utilitarian purpose (Veblen 1914). GRE adds a distributional question: which positions possess sufficient slack and access to follow an aesthetically generated curiosity whose future usefulness is unknown?

Curiosity also resists simple preference models. A person may not possess a stable preference for an object before encountering it. The encounter itself can alter what becomes desirable, intelligible, or askable. Exposure to a musical form, mathematical proof, landscape, craft process, architectural space, language, or artistic tradition can generate new standards of appreciation and new desires for participation. In such cases, the preference space is partly generated through the relation rather than fully specified before it.

Proposition 23.336 (Aesthetic-curiosity option condition). *When aesthetic encounter can generate new questions, practices, preferences, or capabilities whose future significance is not known in advance, economic evaluation should distinguish the present cost of preserving exploratory possibility from a requirement that the encounter already possess demonstrable market or instrumental return.*

The distinction gives aesthetic curiosity a place within generative analysis without assigning it automatic priority. Scarce resources still require judgment. The point is narrower: immediate monetization is an incomplete criterion for deciding whether exploratory aesthetic possibilities deserve institutional or material support.

23.14.5 Value Formation

Value formation is the fifth interface because aesthetic judgment can participate in the generation of economic value without being reducible to it. Products, services, places, performances, crafts, interfaces, brands, institutions, and cultural practices can acquire economic significance partly through perceived form, style, atmosphere, symbolic association, authenticity, originality, coherence, or beauty. These qualities can influence willingness to pay, reputation, demand, differentiation, preservation, labor valuation, and investment. Yet the mechanism is not adequately described by attaching an exogenous preference parameter to a finished object.

Taste has histories. Bourdieu's analysis of distinction emphasizes that aesthetic dispositions are socially formed and implicated in classed practices (Bourdieu 1984). Hume's account of cultivated taste likewise emphasizes practice and comparison, though within a different philosophical project (Hume 1985). GRE can use the shared warning without collapsing their theories: valuation often depends on capacities, repertoires, institutions, and relations that develop over time. The economic value of an aesthetic object can therefore depend on prior investments in education, exposure, cultural infrastructure, communities of practice, criticism, preservation, and recognition.

Definition 23.337 (Aesthetic-to-economic value-formation record). An *aesthetic-to-economic value-formation record* identifies the aesthetic judgments or qualities that are hypothesized to affect economic valuation; the positions and communities in which those judgments are formed; the institutions, classifications, reputations, or distribution channels that mediate conversion; the economic outcomes affected; and the aesthetic value claims that remain independent of the observed economic result.

The record makes several conversion pathways distinguishable. Aesthetic judgment can increase demand directly; institutional recognition can alter reputation and scarcity; a distinctive form can support brand differentiation; cultural prestige can change labor and asset valuation; an aesthetically coherent environment can increase participation or retention; and design can reduce cognitive or interaction costs. These pathways do not have identical normative or aesthetic meaning. The same aesthetic object can also be economically valuable through one pathway and economically marginalized through another.

Value formation is reciprocal. Economic institutions can influence aesthetic standards by changing which objects are produced, distributed, preserved, taught, exhibited, recommended, or rewarded. Market success can become a signal used in later judgment. Wealth can purchase exposure and training. Institutions can canonize some forms while leaving others weakly visible. Production technologies can expand the feasible design space while standardizing other dimensions. Economic conditions therefore enter the history of taste and aesthetic practice without fully determining them.

Proposition 23.338 (Aesthetic-economic conversion condition). A claim that *aesthetic judgment generates or transforms economic value should identify the mediation pathway through which judgment changes demand, access, participation, reputation, differentiation, cost, capability, institutional recognition, or future options, rather than inferring economic value formation from the mere coexistence of aesthetic appraisal and economic outcome.*

This requirement creates empirical answerability. If demand persists when aes-

thetic appraisal changes, another mechanism may dominate. If institutional recognition changes price without changing local aesthetic judgment, the relevant pathway may be status or scarcity. If aesthetically valued design increases participation but not revenue, the economic consequence may lie in capability or institutional continuity rather than market price. GRE should preserve these differences instead of translating them prematurely into one scalar notion of value.

23.14.6 Economic Conditions of Aesthetic Possibility

The sixth interface reverses the direction of explanation. Rather than asking how aesthetic judgment affects economic outcomes, it asks how economic organization conditions what aesthetic experiences, practices, judgments, and forms of participation become possible. Aesthetic possibility is materially situated. Production requires time, tools, spaces, materials, training, infrastructures, and often communities. Reception likewise depends on access to environments, performances, texts, objects, languages, networks, mobility, and discretionary attention. The distribution of those conditions can widen or narrow the aesthetic world available to different positions.

Economic conditions operate at several levels. Household income can affect access to lessons, instruments, travel, museums, books, or performance spaces. Employment conditions can affect discretionary time and cognitive availability. Urban land prices can alter the survival of studios, workshops, informal venues, and public cultural spaces. Intellectual-property arrangements can shape access and reuse. Platform economics can affect discoverability and compensation. Public funding can preserve practices whose market demand is weak or volatile. Education can expand the repertoires through which unfamiliar forms become intelligible. None of these mechanisms determines what a person will find beautiful or worthwhile, but each can alter the feasible space within which aesthetic relations form.

Definition 23.339 (Aesthetic possibility profile). An *aesthetic possibility profile* specifies the time, security, access, spaces, materials, tools, mobility, education, mentorship, communities, infrastructures, legal permissions, distribution channels, and institutional supports through which a position can encounter, create, interpret, compare, preserve, or participate in aesthetically organized practices within a stated horizon.

The profile should not be mistaken for a measure of aesthetic achievement. Abundant resources do not guarantee compelling work or refined judgment. Scarcity does not preclude aesthetic richness. Economic conditions influence possibility, persistence, reach, and vulnerability rather than determining aesthetic outcome. This distinction parallels the capability architecture developed elsewhere in the book: resources require conversion into actual opportunities, and realized activity remains distinct from the value or quality of what is produced.

The profile also reveals collective dependence. Some aesthetic possibilities exist only because institutions preserve archives, maintain public spaces, support ensembles, teach traditions, maintain craft supply chains, conserve landscapes, or sustain communities of interpretation. Their economic conditions cannot be reconstructed from individual purchasing power alone. A financially affordable object may still be aesthetically inaccessible where language, training, mobility, social permission, or cultural familiarity is missing. Conversely, a public institution can widen access even when individual incomes remain unequal.

Proposition 23.340 (Condition–realization non-equivalence). *Economic resources and institutions can enlarge or restrict aesthetic possibility by changing feasible access, production, learning, comparison, preservation, and participation, while the existence of those conditions does not by itself establish aesthetic realization, quality, significance, or value.*

This proposition protects the interface in both directions. Economic analysis should not infer aesthetic success from expenditure, and aesthetic inquiry should not ignore the material structures that make sustained creation and participation unequally possible.

23.14.7 Aesthetic Value and Economic Value

The seventh interface requires an explicit distinction between aesthetic value and economic value. The two can interact, but they are not automatically commensurable. Economic value in GRE already includes heterogeneous processes of generation, conversion, circulation, return, capture, dissipation, and regeneration. Even within the economic domain, value cannot always be reduced to price. Aesthetic value introduces a further domain-specific plurality because its relevant standards can involve beauty, expressive force, coherence, depth, originality, fittingness, experiential intensity, craft, form, atmosphere, or other qualities whose justification belongs to aesthetic practices and traditions.

The distinction is easiest to see in cases of divergence. A work can command a high price while being aesthetically disputed. A public artwork can have little market value but substantial significance to a community. A design can be commercially successful because it is familiar and legible while specialists regard it as aesthetically conventional. An experimental practice can possess high aesthetic importance within a field while lacking a stable market. A landscape can have aesthetic value for residents even where market valuation is weak or where monetization would alter the relation being valued.

Definition 23.341 (Aesthetic-value translation record). *An aesthetic-value translation record specifies the aesthetic value claim, the economic value concept to which a translation is proposed, the mechanism and institutional procedure through which the translation occurs, the scope within which comparison is intended, the evidence supporting the translation, and the aesthetic remainder that the economic representation does not preserve.*

Translation can sometimes be legitimate. Insurance, compensation, budgeting, conservation, commissioning, procurement, or cultural-policy decisions may require economic representation of aesthetically valued objects. Such representation can be practically necessary without proving that the underlying values are identical. A public decision may assign a monetary amount to preservation because budgets require commensuration, while the justification for preservation continues to depend on aesthetic, historical, ecological, civic, or cultural reasons that exceed the assigned amount.

This is also where preference language requires care. Economic choice can reveal how a person acts under a specific budget, option set, information environment, and institutional arrangement. It does not reveal the complete structure of aesthetic value. Preferences can be learned, transformed by exposure, constrained by access, affected by status, or altered through participation. Bourdieu's account of socially

structured taste reinforces the point that observed choice can reflect histories of formation rather than a timeless internal ordering (Bourdieu 1984).

Proposition 23.342 (Aesthetic-economic value non-equivalence). *Aesthetic value and economic value should be treated as non-equivalent unless a bounded translation procedure is explicitly justified for the relevant object, institution, decision, and horizon; observed correlation between aesthetic appraisal and economic valuation does not establish identity between the two value relations.*

The proposition does not prohibit comparison. It requires scope. A museum may compare acquisition costs, expected attendance, conservation burdens, and curatorial judgments. A city may compare design alternatives through cost, accessibility, maintenance, public use, and aesthetic criteria. A household may choose among objects through price and taste simultaneously. In each case, practical judgment can combine several dimensions while preserving their distinct meanings.

23.14.8 Limits of Economic Translation

The final interface concerns what remains after economically consequential aspects of aesthetic life have been represented. GRE can study the distribution of artistic labor, the economics of cultural institutions, aesthetic differentiation in markets, the resource conditions of creation, the attention effects of design, the conversion of reputation into price, the role of aesthetic judgment in selection, and the inequalities that structure participation. None of these objects authorizes GRE to treat aesthetic experience or value as economically exhausted.

A first limit concerns phenomenology and experience. An account of expenditure, access, and demand does not reconstruct what an experience feels like, how form unfolds through time, or why a relation becomes moving, unsettling, beautiful, ugly, sublime, coherent, or expressive. Dewey's processual aesthetics is relevant precisely because aesthetic experience is organized through interaction and temporal development rather than reducible to ownership of an object (Dewey 1934). Economic analysis can identify conditions of access and consequence while leaving the constitution of experience open.

A second limit concerns standards and criticism. Economic success can become one datum within an aesthetic field, but it cannot substitute for the field's critical practices. Whether a work is derivative, formally innovative, coherent, manipulative, profound, kitsch, technically accomplished, or historically important requires interpretive and comparative judgments whose warrants are not supplied by revenue or audience size alone. Those standards can themselves be disputed and historically formed, but contestation does not make them equivalent to market outcomes.

A third limit concerns relation-specific value. Some aesthetic relations are altered by commodification. A ritual object, shared landscape, vernacular practice, community performance, or public space can acquire a different meaning when access, ownership, reproduction, or display is reorganized around market exchange. GRE can study that transformation, including capture, exclusion, displacement, and changing participation. The transformation itself is evidence that economic translation may modify the object rather than merely measure a stable pre-economic value.

Definition 23.343 (Aesthetic relational remainder). *An aesthetic relational remainder is the set of experiential qualities, form-sensitive judgments, historically situated standards, meanings, practices, relations of participation, or domain-specific value*

claims that remain analytically material after the economic consequences and conditions of an aesthetic object have been represented and that cannot be warranted from the economic representation alone.

The remainder is not a declaration that aesthetics possesses a fixed and impermeable jurisdiction. Domain boundaries remain revisable. It is a discipline of non-erasure. When economic analysis translates aesthetic objects into demand, price, labor, access, attention, capability, or institutional cost, it should state what the translation does not preserve.

Definition 23.344 (Aesthetics correction return). An *aesthetics correction return* is a finding from aesthetic inquiry or a relevant practice of criticism, design, art, architecture, craft, or cultural interpretation that requires GRE to revise an assumed judgment type, salience mechanism, orientation pathway, curiosity account, value-formation mechanism, possibility profile, or economic translation.

Correction can also move toward aesthetics. GRE may reveal that apparent freedom of taste depends on unequal access, that an institution's canon is reinforced by concentrated funding, that aesthetic labor is sustained through hidden unpaid work, that a design convention creates economic dependence, that platform ranking narrows exposure, or that a community's aesthetic practice becomes vulnerable through property or land-market change. These economic findings do not settle aesthetic value, but they can change how the conditions of judgment and practice are understood.

Definition 23.345 (GRE–aesthetics interface portfolio). A *GRE–aesthetics interface portfolio* is a versioned collection of aesthetic-judgment profiles, salience pathways, orientation analyses, curiosity profiles, value-formation records, aesthetic possibility profiles, value-translation records, aesthetic relational remainders, and correction returns across projects.

Proposition 23.346 (GRE–aesthetics interface answerability). A *GRE–aesthetics interface* is answerable when the aesthetic object or judgment, economic condition or consequence, translation pathway, domain-specific remainder, evidence, boundary, and possible correction returns are explicit enough that contrary economic or aesthetic analysis can revise the mechanism, narrow the claim, alter the proposed translation, or withdraw it.

The interface therefore gives aesthetics a bounded but consequential position within GRE. Aesthetic judgment can shape salience, direct orientation, provoke curiosity, participate in value formation, influence design and participation, and alter how scarce attention and resources are allocated. Economic organization can in turn distribute the time, security, spaces, infrastructures, exposure, training, tools, and institutional recognition through which aesthetic possibility develops. These relations justify sustained economic inquiry while preserving the non-equivalence of aesthetic and economic value. The next section turns from neighboring domains to GRE's outward contribution. Section 540 asks which concepts GRE can export to other domains, under what translation conditions, and with what restrictions against treating economic formulations as universal GR vocabulary.

23.15 Cross-Domain Portability of GRE Concepts

The preceding interfaces examined how history, governance, law, political theory, education, ecology, artificial-intelligence studies, social theory, and aesthetics can correct or extend an economic inquiry without being absorbed into it. The present section reverses the direction of travel and asks which analytical resources developed within Generative Relational Economics can be useful to neighboring domains. Its role in Chapter 23 is therefore neither to enlarge GRE's jurisdiction nor to propose a completed general Generative Relational Theory. Its objective is to identify concepts whose internal structure may be portable while preserving the economic typing, evidential warrant, normative authority, and domain-specific remainders that made those concepts meaningful in their original setting. The discussion considers eight candidate resources: relational allocation, generative value, value conversion, value circulation, economic generativity, economic asymmetry, economic participation, and economic spacetime. The method is comparative and translation-sensitive. Each candidate is decomposed into a potentially portable analytical kernel and a set of economic commitments that require revalidation, modification, or removal when the concept enters another domain.

The language of “export” is therefore used only as shorthand for disciplined outward transfer. A concept developed in GRE can become useful elsewhere because it highlights a question, distinction, relational structure, or research operation that a neighboring domain also needs. Such usefulness does not establish that the GRE formulation is the most general formulation, that the receiving domain lacks its own prior concepts, or that the transferred vocabulary should displace domain-specific terminology. The translation discipline developed in Section 23.3 applies with particular force here because the originating framework has an obvious incentive to overestimate the generality of its own constructions.

Definition 23.347 (GRE outward-transfer record). A *GRE outward-transfer record* identifies a GRE concept proposed for use in another domain, its original economic problem, the analytical structure proposed for preservation, the economic assumptions or value commitments that should not transfer automatically, the receiving domain's corresponding object and warrant, anticipated translation losses, domain-specific remainders, and the conditions under which the receiving domain should revise or reject the transfer.

The record turns outward contribution into an answerable interface rather than a vocabulary claim. For example, the distinction between nominal receipt and effective conversion can be useful in education, law, or governance, yet the relevant resource, recipient, capability, institution, and evaluative standard must be reconstructed locally. A relational-allocation model of educational opportunity cannot assume that an educational good is adequately specified by its economic cost. A value-conversion model of ecological restoration cannot assume that ecological value is an economic value form. A participation model used in political inquiry cannot infer political standing from economic participation.

Definition 23.348 (Portable analytical kernel). A *portable analytical kernel* is the smallest explicitly stated structure of a GRE concept that can be proposed for cross-domain use without requiring the receiving domain to adopt the concept's full economic semantics, original evidential assumptions, or normative commitments.

The kernel is deliberately smaller than the source concept. It may consist of a dis-

Table 23.15: Candidate GRE resources for cross-domain analytical transfer

GRE resource	Portable analytical kernel	Illustrative receiving ques- tions	Non-automatic trans- fer
Relational allocation	Allocation changes relations, enabling conditions, incidence, and later possibilities in addition to nominal holdings	Educational opportunity, legal access, governance authority, ecological stewardship, institutional capacity	Economic scarcity assumptions, monetary comparability, administrative recipient types
Generative value	Present processes can be evaluated partly through later valuable capacities or possibilities under an explicit standpoint and horizon	Learning, institutional capacity, ecological regeneration, cultural continuity, public knowledge	The receiving domain's value standard and normative authority
Value conversion	Heterogeneous value-bearing conditions may change type through identifiable interfaces with losses and asymmetries	Knowledge use, rights realization, capability formation, ecological or cultural translation	A common metric, exchange rate, or economic definition of value
Value circulation	Value-bearing effects can move, return, concentrate, dissipate, or be captured through traceable pathways	Knowledge circulation, institutional return, community benefit, cultural reproduction	Identity between physical movement, symbolic circulation, and value circulation
Economic generativity	Present relations can change later capacities, rules, option spaces, and conditions of further generation	Education, governance, history, law, ecology, technology	Positive value, progress, teleology, or economic mechanism
Economic asymmetry	Position-relative differences require typed comparison and a mechanism before being interpreted as dependence or power	Epistemic, legal, political, technological, educational, ecological relations	A universal metric of advantage or automatic inference to power
Economic participation	Participation includes practical access, consequential contribution, standing, recognition, capability effects, dependency, and exit	Education, governance, organizations, AI mediation, community processes	Citizenship, legal personality, moral standing, or political legitimacy
Economic spacetime	Temporal order and relational position can jointly condition accessibility, trajectory, delay, and later possibility	Historical process, policy timing, institutional change, education, ecology, AI diffusion	Physical spacetime ontology, relativistic structure, or one universal geometry

tion, a sequence of analytical questions, a typed relation, a provenance requirement, or a formal pattern. Portability becomes stronger when the receiving domain can reconstruct the kernel using its own objects and evidence rather than merely reusing economic terminology.

Proposition 23.349 (Portability without universalization). *Successful use of a GRE concept in a neighboring domain supports the portability of the preserved analytical structure for the stated task; it does not by itself establish that the concept is a universal GR primitive, a domain-independent ontology, or a replacement for the receiving domain's own conceptual architecture.*

Table 23.15 summarizes the eight outward-transfer candidates developed below. The final column is as important as the portable kernel because it records what should remain open after translation.

23.15.1 Relational Allocation

Relational allocation was developed most fully in Chapters 12 and 13 to correct an overly narrow representation of allocation as a transfer of a quantity to a nominal recipient. GRE retains the administrative importance of recipients and holdings while asking additional questions about access, usability, control, enabling conditions, higher-order relations, temporal sequencing, spatial incidence, dependency, and later possibility. The potentially portable contribution is therefore not a par-

ticular economic allocation rule. It is an analytical discipline for examining how an intervention changes a relational configuration beyond the moment of formal assignment.

The kernel can be stated through a sequence of questions. What is being allocated or reorganized? Which position is formally recognized as recipient or bearer? Which complementary conditions determine effective use? Which relations among positions are altered? Which higher-order institutions or infrastructures change? How do incidence and consequences propagate across time and scale? Which later capacities, dependencies, or options become more or less reachable? Neighboring domains can reconstruct these questions around objects that are not primarily economic.

Education provides one example. A scholarship can be represented economically as a transfer of resources, but an educational analysis may also examine mentorship, admission, time, language access, institutional belonging, pedagogical attention, laboratory access, peer relations, and the capacity to continue learning. Law provides another example. A formal entitlement can allocate a right while practical access depends on information, representation, procedural capacity, enforcement, and institutional recognition. Governance can allocate decision authority, agenda access, or administrative capacity. Ecological governance can allocate stewardship duties, monitoring access, use rights, restoration responsibility, or burdens of conservation. In each case, the useful transfer lies in distinguishing nominal assignment from relationally realized consequence.

Definition 23.350 (Relational-allocation portability profile). *A relational-allocation portability profile specifies the receiving domain's allocable object or condition, formal recipient or bearer, conversion and enabling conditions, affected relations and higher-order structures, temporal and spatial incidence, later capability or option effects, relevant evidence, and the economic assumptions removed or modified during transfer.*

The profile should preserve the receiving domain's own object types. In education, attention and pedagogical opportunity may require a different account from financial resources. In law, rights and duties are not interchangeable with commodities. In political inquiry, authority cannot be treated as a stock distributed without regard to legitimacy and institutional form. The relational-allocation kernel travels most successfully when it prompts a richer incidence analysis while allowing the receiving domain to specify what allocation means.

A further caution concerns causality. A relational consequence that follows an allocation is not necessarily the purpose of the allocation, and a later difference among positions is not necessarily attributable to the allocation alone. Cross-domain use therefore requires historical and comparative evidence adequate to the receiving question. Relational breadth should increase explanatory resolution rather than convert every downstream change into an allocative effect.

Proposition 23.351 (Recipient non-exhaustion across domains). *Where an allocation-like intervention materially changes access, enabling conditions, relations, institutional structures, or later feasible possibilities, analysis of the formal recipient alone can be insufficient for the receiving domain's question; the additional relational effects should be specified using that domain's own object and evidence standards.*

Relational allocation is therefore portable mainly as a way of asking what an assignment changes around and after the recipient. Its economic origin remains visible, while its wider analytical value depends on reconstruction rather than lexical

adoption.

23.15.2 Generative Value

Generative value in Chapter 14 distinguishes immediate realization from the value of conditions or processes that support later generation. The concept is explicitly evaluative. It therefore carries a greater translation burden than relational allocation. Its portable kernel is the requirement to examine whether present arrangements contribute to later valuable capacities, relations, institutions, opportunities, or regenerative conditions under a specified standpoint, for identified subjects or affected positions, across an explicit horizon. The kernel does not determine what counts as valuable in the receiving domain.

This distinction matters because neighboring domains frequently confront processes whose significance is temporally distributed. Education can create capacities for later inquiry and participation. Legal institutions can preserve procedural capabilities and expectations that make later action possible. Governance can develop institutional memory and coordination capacity. Ecological restoration can alter later regenerative conditions. Cultural and aesthetic institutions can preserve practices, repertoires, spaces, and communities through which future creation becomes possible. In each case, a generative perspective asks how present activity changes the conditions of later possibility. The receiving discipline still determines the relevant good and the standards through which its value is warranted.

Definition 23.352 (Generative-value portability record). A *generative-value portability record* identifies the receiving domain's value-bearing object or process, the standpoint from which value is attributed, affected subjects or positions, the later capacity or possibility claimed to be supported, the generative mechanism, temporal horizon, uncertainty, possible harms or foreclosures, and the domain-specific warrant for treating the generated condition as valuable.

The final element is indispensable. Generativity and value remain distinct. A process can be highly generative in the descriptive sense while producing capacities that are harmful, exclusionary, coercive, ecologically destructive, or otherwise undesirable. A propaganda institution can become more capable of reproducing itself. A discriminatory legal arrangement can stabilize expectations and generate institutional competence in exclusion. A technically efficient surveillance system can enlarge informational capability while narrowing freedom. The existence of later-producing capacity does not establish its desirability.

This distinction also guards against a teleological reading. Generative value does not mean that later states are inherently better because they are later or because more activity can be generated. The relevant standpoint may value preservation, repair, restraint, reversibility, diversity, continuity, or the maintenance of conditions that prevent destructive generation. A receiving domain can therefore use the generative-value kernel without adopting a growth orientation.

Proposition 23.353 (Domain-retained value authority). *When a generative-value concept is transferred from GRE, the receiving domain retains responsibility for establishing what counts as valuable, for whom, under which normative or evaluative standard, and across which horizon; the existence of a generative mechanism does not transfer evaluative authority from economics.*

The portable contribution is consequently temporal and relational rather than nor-

matively sovereign. It encourages inquiry into how present conditions reproduce or transform later valued possibilities while requiring the receiving discipline to defend the value claim in its own terms.

23.15.3 Value Conversion

Value conversion in Chapter 14 was introduced to analyze situations in which a value-bearing condition in one form becomes, enables, or is transformed into another. GRE uses the concept because monetary value, capability, knowledge, legitimacy, infrastructure, status, ecological condition, institutional capacity, and other value-bearing forms can interact without being reducible to one common unit. The portable kernel is therefore a typed interface analysis: identify the source form, target form, conversion mechanism, enabling conditions, losses, delays, asymmetries, and affected positions before claiming that one value relation produces another.

A neighboring domain can use this structure without accepting an economic theory of value. Knowledge can be converted into institutional practice through training, authority, documentation, and organizational routines. A legal right can become practical capability through information, representation, enforcement, and material support. Educational attainment can become occupational access through credential recognition, networks, labor-market institutions, and organizational selection. Ecological knowledge can become stewardship capacity through local authority, monitoring infrastructure, financing, and collective organization. Cultural recognition can become institutional support through curation, funding, public legitimacy, and organizational sponsorship. These examples differ in object and warrant, yet each contains a nontrivial interface between value-bearing states or capacities.

Definition 23.354 (Cross-domain conversion-interface profile). A *cross-domain conversion-interface profile* records a source value-bearing condition, a target value-bearing condition defined by the receiving domain, the mechanism connecting them, necessary enabling conditions, institutional interfaces, temporal delay, conversion losses, possible capture or exclusion, uncertainty, and the evidence required to establish that the proposed conversion has occurred.

The profile keeps conversion distinct from several neighboring operations. Measurement represents a condition through an indicator. Translation maps concepts or evidence across representational systems. Exchange transfers claims or objects under institutional rules. Circulation traces movement or recurrence. Conversion claims a change in value-bearing form or realized function. These operations can occur together, but collapsing them can hide the mechanism under investigation.

Conversion analysis is especially useful where formal possession differs from realization. A right can exist without being exercisable. Information can exist without becoming knowledge usable by a particular position. Funding can exist without producing institutional capability. Recognition can exist symbolically without changing access or standing. The conversion question directs attention toward the interfaces that make a value-bearing condition actionable.

Proposition 23.355 (Typed conversion portability). A *value-conversion structure* is portable across domains when the receiving analysis can define the source and target types independently, identify a plausible conversion mechanism and enabling conditions, and state the losses or exclusions introduced by the interface without presuming a common metric between the two value-bearing conditions.

This proposition makes non-commensurability compatible with analysis. Two value-bearing conditions can be related without being measured on one scale. Cross-domain conversion becomes a mechanism question first and a commensuration question only where the receiving task actually requires comparison.

23.15.4 Value Circulation

Value circulation and recirculation in Chapter 14 extend value analysis beyond a single generation event. The relevant questions concern where value-bearing effects travel, which positions receive or lose them, whether they return toward the conditions that supported their generation, where they accumulate, how they dissipate, and through which interfaces they are captured. The potentially portable kernel is a pathway and provenance analysis rather than a claim that value behaves like a conserved substance.

This distinction matters when the concept enters neighboring domains. Knowledge can circulate among researchers, institutions, publics, and technologies, yet the movement of documents is not identical to the circulation of usable knowledge. Cultural forms can circulate while recognition, revenue, authority, and interpretive control remain concentrated. A legal innovation can diffuse across jurisdictions while practical rights remain uneven. Institutional learning can move through personnel and standards while local capability erodes. Ecological benefits can be produced in one place while burdens or risks are displaced elsewhere. A circulation vocabulary becomes informative only when the analyst specifies what is moving, what is being regenerated, and how the receiving position changes.

Definition 23.356 (Cross-domain value-circulation profile). A *cross-domain value-circulation profile* specifies the value-bearing condition under study, originating relations and contributors, carriers or transmission media, intermediate conversions, recipient and affected positions, return pathways, sites of accumulation or capture, dissipation or loss mechanisms, temporal horizon, and the domain-specific evidence used to infer circulation.

The profile prevents a recurrent category error in which movement of a carrier is treated as movement of value itself. A dataset may be copied widely while remaining unusable without expertise. Money may return to a community while decision authority leaves it. A cultural work may receive global exposure while the community that sustains the practice receives little recognition or material support. Conversely, a value-bearing effect can circulate without a single material carrier moving intact, as when learning propagates through teaching, adaptation, imitation, and institutionalization.

The idea of return is similarly domain-sensitive. Return need not mean repayment to an original individual contributor. A receiving domain may identify maintenance of a shared institution, restoration of an ecological substrate, replenishment of a knowledge commons, preservation of a cultural practice, or expansion of future participation as a relevant return. Whether such a return is normatively appropriate remains an independent question.

Proposition 23.357 (Carrier-value distinction). *Cross-domain claims of value circulation should distinguish the movement of physical, financial, informational, legal, symbolic, or organizational carriers from the generation, preservation, conversion, or realization of the value attributed to those carriers within the receiving domain.*

Value circulation is therefore portable when it improves provenance: who contributed, what moved, what changed form, who benefited, what returned, what was captured, and what conditions were reproduced or depleted. The concept should be withdrawn where no identifiable value-bearing pathway can be distinguished from ordinary movement, communication, or diffusion.

23.15.5 Economic Generativity

Generativity is one of the most portable concepts used by GRE and therefore one of the concepts most vulnerable to premature generalization. Within the economic domain, generativity concerns the capacity of present relations, institutions, resources, events, or processes to alter what can be generated later. Chapters 12–20 apply this idea to capability, value, infrastructure, power, knowledge, artificial intelligence, participation, institutions, and economic order. The portable kernel is a future-forming mechanism: a present configuration modifies later capacities, relations, rules, state spaces, option structures, or conditions of further transformation.

This kernel can be reconstructed in many neighboring domains. Education can alter the capacity to learn and inquire later. Law can stabilize or modify the rules through which future claims and relations become possible. Governance can create administrative capacity, institutional memory, and revisable procedures. Historical processes can change the repertoire of available institutions or identities. Ecological processes can reproduce or degrade conditions for later life and regeneration. Technological systems can expand capacities while generating new dependencies. Social relations can reproduce categories, positions, expectations, or networks that condition later action.

Definition 23.358 (Cross-domain generativity kernel). A *cross-domain generativity kernel* identifies a present relation, event, institution, or process; a receiving-domain object that can be generated, reproduced, transformed, or foreclosed; a mechanism connecting present and later conditions; a temporal horizon; relevant feedback or maintenance relations; uncertainty; and evidence capable of distinguishing the proposed generative pathway from mere temporal succession.

The last requirement is central. A later state following an earlier state does not establish generativity. The analyst needs a mechanism or evidential basis for claiming that the earlier configuration helped produce or constrain the later possibility. Historical path dependence, institutional reproduction, developmental learning, ecological regeneration, and technological lock-in can all support generative claims, but their mechanisms differ.

A second restraint concerns normativity. Generativity can support valued possibilities, reproduce harmful institutions, increase concentration, create dependence, amplify fragility, or narrow future option spaces. The same process can be generative along one dimension and depletive along another. The concept therefore gains analytical value when the object of generation is typed rather than when “generative” becomes an honorific adjective.

Proposition 23.359 (Typed generativity transfer). A *generativity concept is portable across domains when the receiving analysis specifies what is generated or foreclosed, by which mechanism, for which positions or systems, across which horizon, and with what evidence; generativity alone does not establish improvement, desirability, progress, or normative priority.*

This condition also clarifies the relation between GRE and a possible future GRT. Repeated domain-specific success of a typed generativity kernel would provide comparative evidence for a broader relational language. It would still leave open whether different domains instantiate one sufficiently common structure to justify general theory. Section 544 will return to that question after the chapter examines imports, non-equivalent concepts, and boundary disputes.

23.15.6 Economic Asymmetry

GRE treats asymmetry as a typed and relation-dependent difference rather than a single scalar ranking. Chapters 16 and 18 show why this discipline matters for power and artificial intelligence: two positions can differ in productive capacity, information, liquidity, legal protection, exit options, recognition, institutional authority, technological capability, or control over conversion interfaces. These differences do not have the same meaning and need not move together. The portable kernel is therefore a comparison architecture that identifies the dimension, relation, reference set, scale, and mechanism through which a difference becomes consequential.

Neighboring domains can benefit from this discipline because asymmetry is pervasive but heterogeneous. Epistemic inquiry can compare access to information, expertise, interpretive capacity, or verification resources. Law can examine asymmetry in procedural capability, enforcement access, legal representation, or institutional recognition. Political theory can examine agenda control, authority, participation, and coercive capacity. Education can examine differences in preparation, mentorship, institutional access, or capacity to convert formal opportunity into learning. AI studies can distinguish technical capability asymmetry from deployment authority, access, verification capacity, and institutional control. Ecological governance can examine asymmetric exposure to environmental burdens or unequal capacity to shape resource decisions.

Definition 23.360 (Cross-domain asymmetry profile). A *cross-domain asymmetry profile* specifies the compared positions, relation in which comparison is meaningful, dimension or capability being compared, scale and horizon, relevant baseline, conversion conditions, dependence or vulnerability pathways, institutional mediators, and the receiving domain's evidence for treating the difference as analytically consequential.

Typed comparison prevents several shortcuts. A difference in one capability does not establish global superiority. A statistically unequal distribution does not automatically establish a relation of domination. Dependence requires a mechanism connecting the weaker position's options to the stronger position or to an institution that controls a relevant interface. Power requires further analysis of how asymmetry is exercised, reproduced, resisted, legitimated, or transformed. These requirements protect the receiving domain from importing GRE's conclusions together with its diagnostic vocabulary.

Asymmetry analysis is also inherently historical. A small initial difference can compound through feedback, while a large observed difference can be temporary or institutionally buffered. Formal equality can coexist with practical asymmetry where conversion conditions differ. Conversely, unequal capacities can coexist with protective institutions that prevent one position from controlling another. The receiving domain therefore needs both a typed comparison and an account of the mechanisms

that translate difference into consequence.

Proposition 23.361 (Asymmetry–power non-identity across domains). *A cross-domain asymmetry establishes a typed difference between specified positions; an inference to dependence, domination, authority, or power requires additional evidence concerning the mechanism through which that difference alters options, control, vulnerability, standing, or the conditions of relation formation.*

The portable contribution is consequently diagnostic precision. It encourages researchers to ask “asymmetry of what, between whom, in which relation, over what horizon, and through which consequential pathway?” without presuming that the economic answer supplies the legal, political, social, or ethical interpretation.

23.15.7 Economic Participation

Economic participation is developed in Chapters 12, 18, and 20 as a broad relation through which subjects or collectives can gain practical access to economically consequential processes, contribute, be recognized, influence decisions, acquire capability, become dependent, and retain or lose viable exit and transition options. The portable kernel is a multidimensional account of participation that distinguishes formal presence from practical access and consequential standing.

This kernel has obvious relevance outside economics. Educational participation can involve admission, attendance, voice, access to instruction, capacity to contribute, recognition of learning, and later capability formation. Governance participation can involve information, agenda access, deliberation, representation, decision standing, and the practical capacity to contest outcomes. Organizational participation can distinguish membership from influence. AI-mediated systems can distinguish a human being present in a workflow from a human retaining consequential judgment or revision capacity. Community institutions can distinguish nominal consultation from durable participation in rule formation and maintenance.

Definition 23.362 (Cross-domain participation profile). *A cross-domain participation profile records eligibility or formal inclusion, practical access, modes of contribution, decision or interpretive standing, recognition, capability effects, dependencies created through participation, burdens and risks, contestation channels, and viable exit or transition conditions, using the receiving domain’s own account of who or what can participate.*

The final clause prevents a particularly serious overextension. GRE’s use of economic participation does not determine political citizenship, legal personality, moral standing, ecological subjecthood, or the philosophical agency of artificial systems. A domain can use the participation profile for positions it independently recognizes without inheriting GRE’s subject classification. The interface with AI studies in Section 23.12, for example, distinguished functional economic agency from broader agency or subjecthood. The same restraint applies here.

Participation also has generative consequences. Repeated involvement can produce skills, knowledge, networks, confidence, institutional memory, identity, dependence, or exclusion. These effects can alter who can participate later and on what terms. A receiving domain can therefore combine the participation kernel with generativity while keeping the two questions distinct: whether participation occurs now and what present participation generates for later relations.

Proposition 23.363 (Participation typing condition). *A participation concept transferred from GRE is adequate only after the receiving domain independently specifies eligible positions, forms of consequential involvement, relevant standing, burdens, capability effects, and exit or revision conditions; economic participation does not confer legal, political, moral, or ontological status outside the economic problem-space.*

The portable contribution is thus an anti-tokenism architecture rather than a universal membership theory. It helps distinguish being counted, being present, being able to act, being heard, having standing, and being able to shape future conditions.

23.15.8 Economic Spacetime

Economic spacetime in Chapter 15 provides a joint representation of temporal order and relational or spatial position where both dimensions materially affect accessibility, trajectory, delay, propagation, and later economic possibility. The term is intentionally representational. GRE does not infer a physical spacetime ontology from the usefulness of modeling economic events through temporal and relational structure. The portable kernel is therefore weaker and potentially more useful: some processes cannot be represented adequately by chronology alone or by a static relational map because when an event occurs and where a position stands jointly condition what becomes reachable next.

Neighboring domains frequently encounter this joint dependence. Historical inquiry can compare trajectories whose later options depend on event order, institutional location, and path-dependent accessibility. Governance can examine policy timing relative to administrative capacity and affected regions or networks. Law can examine sequences in which jurisdiction, status, procedural stage, and timing jointly determine available remedies. Education can examine learning trajectories where prior knowledge, institutional position, and timing condition access to later opportunities. Ecology can examine spatially distributed processes with delayed effects and cross-scale propagation. AI studies can examine uneven diffusion of technical capability, infrastructure, institutional adoption, and regulatory response across heterogeneous locations and organizational positions.

Definition 23.364 (Cross-domain spacetime portability profile). *A cross-domain spacetime portability profile specifies the receiving domain's event or process types, temporal ordering, modeled positions or locations, accessibility relations, delays, trajectories, relevant boundaries, scale relations, observables, and the claim that would be lost if time and position were analyzed separately.*

The final requirement keeps the representation proportional. Many questions need only chronology. Others need only a network, map, institutional hierarchy, or sequence model. Spacetime language earns its place when the interaction between temporal order and position changes the inference. A policy introduced at the same calendar date can reach regions at different effective times because administrative infrastructure differs. The same legal rule can generate different trajectories when jurisdictional position or prior procedural history differs. An educational opportunity can become available too late for one trajectory even if the nominal resource eventually reaches the learner.

The kernel can also preserve heterogeneous presents. Different positions may inhabit different effective states at the same clock time because information, infrastructure, rights, capabilities, or institutional responses arrive unevenly. This observa-

tion can be useful without invoking relativity or a common geometry across domains. The receiving discipline defines the relevant notion of accessibility and the evidence through which it is observed.

Proposition 23.365 (Cross-domain spacetime proportionality). *A spacetime-style representation is portable to a neighboring domain when temporal order and modeled position jointly alter the target mechanism, accessibility relation, trajectory, or reachable alternatives and when a simpler chronology or static relational representation would omit that joint dependence.*

Economic spacetime is therefore best exported as a disciplined representational question rather than a metaphysical template. It asks whether process, position, accessibility, and history need to be modeled together, then leaves the receiving domain to specify the geometry, topology, ordering, institutional structure, or qualitative narrative appropriate to its evidence.

The eight candidates considered in this section vary substantially in portability. Relational allocation, typed asymmetry, participation profiling, and spacetime representation can often travel as analytical question structures. Generative value and value circulation carry heavier evaluative and semantic burdens. Value conversion requires explicit source and target types. Generativity is highly portable as a future-forming question while remaining especially vulnerable to rhetorical overextension. These differences should be recorded rather than hidden under a generic claim of interdisciplinarity.

Definition 23.366 (GRE portability portfolio). *A GRE portability portfolio is a versioned collection of outward-transfer records, portable analytical kernels, receiving-domain reconstructions, translation-loss ledgers, domain-specific remainders, correction returns, rejected transfers, and evidence about which GRE structures remain useful after domain-specific revalidation.*

Rejected transfers belong in the portfolio because failure is theoretically informative. A concept can prove too dependent on economic institutions, too normatively loaded, too vague outside its originating problem, or already better represented by a receiving discipline's own vocabulary. Such outcomes narrow GRE's claims and improve the comparative basis for any later generalization.

Proposition 23.367 (Outward-contribution answerability). *A claimed GRE contribution to a neighboring domain is answerable when the originating economic concept, portable kernel, receiving object, reconstruction procedure, evidence, translation losses, retained domain-specific remainder, and revision or rejection conditions are explicit enough that researchers in the receiving domain can modify, localize, or refuse the proposed transfer.*

Outward portability strengthens GRE when it exposes the limits of GRE's own formulations. Successful reconstruction across several domains may reveal a reusable analytical structure, while failed transfer can reveal economic specificity. Neither outcome justifies disciplinary absorption. Section 541 examines the concepts and insights GRE must import from neighboring domains to remain empirically adequate and disciplinarily answerable.

23.16 Neighboring-Domain Contributions to GRE

Section 23.15 examined how analytical structures developed within Generative Relational Economics may travel outward without becoming universal claims. The present section examines the reciprocal direction. Its role in Chapter 23 is to specify how GRE can depend on knowledge generated elsewhere while preserving the disciplinary authority, evidential basis, conceptual distinctions, and normative judgments of the contributing domain. The objective is not to assemble a catalogue of external ideas around an otherwise self-sufficient economics. Economic relations are often historically formed, legally constituted, politically organized, educationally reproduced, ecologically bounded, aesthetically oriented, socially embedded, and technically mediated. A GRE claim can therefore become answerable only by making such dependencies visible. The section considers historical reconstruction, governance requirements, legal categories, political power, educational generativity, ecological constraint, aesthetic judgment, and domain-specific correction returns. The method is provenance-preserving and dependency-sensitive: an imported premise is translated for an economic question without being redescribed as if GRE had independently established it.

The language of “import” is used here as shorthand for disciplined incorporation. It does not imply ownership of the imported concept, priority over the source discipline, or semantic identity before and after translation. Some contributions enter GRE as constitutive categories, some as empirical constraints, some as interpretive warrants, some as normative limitations, and some as counterevidence. These different roles should remain distinguishable because a legal status, an ecological threshold, a historical reconstruction, and an aesthetic judgment do not acquire the same epistemic status merely because each affects an economic analysis.

Definition 23.368 (GRE inward-interface record). A *GRE inward-interface record* identifies a contribution from a neighboring domain, the source-domain question and warrant supporting that contribution, the GRE question for which it becomes relevant, the translation required for economic use, the source-domain distinctions that remain authoritative, the economic claims that depend on the contribution, and the conditions under which correction or withdrawal in the source domain requires revision inside GRE.

Definition 23.369 (External-warrant dependency). An *external-warrant dependency* exists when a GRE claim materially relies on a premise whose principal evidential, conceptual, or normative justification belongs to a neighboring domain rather than to GRE itself.

External-warrant dependency is not a defect. It is one consequence of disciplinary containment. The defect would arise when a cross-domain dependency is hidden and GRE presents the resulting conclusion as if its economic evidence also established the historical, legal, political, ecological, educational, aesthetic, social, or technical premise on which the conclusion rests.

Proposition 23.370 (Provenance-preserving incorporation). *When a GRE conclusion depends materially on a neighboring-domain premise, disciplined incorporation preserves the provenance and epistemic status of that premise, states the economic transformation applied to it, and leaves the dependent GRE conclusion revisable if the source-domain warrant is materially revised.*

Table 23.16 summarizes the principal contribution classes developed below. The

Table 23.16: Principal neighboring-domain contributions to GRE

Source domain	Contribution to GRE	Economic claims potentially revised	Authority retained outside GRE
History and GRH	Formation sequence, contingency, inherited constraint, path dependence, multiple timescales	Causal interpretation, counterfactuals, persistence, transition, temporal scope	Historical reconstruction, periodization, source interpretation, event significance
Governance and GRG	Authority, coordination, implementation, learning, response horizons, uncertainty management	Intervention feasibility, institutional response, policy transmission, adaptive capacity	Governance design, legitimate authority, administrative practice, institutional evaluation
Law and jurisprudence	Property, contract, personhood, rights, duties, recognition, legal infrastructure	Control, entitlement, liability, exchange conditions, standing, enforceability	Legal validity, doctrinal meaning, institutional recognition, juridical status
Political theory	Power, authority, legitimacy, publicness, collective action, political recognition	Power attribution, bargaining environment, public allocation, institutional stability	Political legitimacy, authority, public standing, political interpretation
Education	Learning, capability formation, curiosity, epistemic participation, developmental conditions	Human capability, knowledge formation, participation, long-horizon generativity	Educational quality, learning warrant, pedagogical judgment, developmental interpretation
Ecology	Biophysical constraint, metabolism, non-human affectedness, ecological value, intergenerational conditions	Feasibility, resource reproduction, externalization, risk, long-horizon value	Ecological measurement, system boundaries, ecological value, non-human standing
Aesthetics	Judgment, salience, orientation, curiosity, form-sensitive evaluation	Attention, demand formation, cultural production, innovation pathways, valuation processes	Aesthetic quality, aesthetic warrant, domain-specific standards of judgment
Other neighboring domains	Domain-specific objects, counterevidence, categories, mechanisms, and correction returns	Any GRE claim whose premises cross the disciplinary boundary	Source-domain evidence, semantics, normative authority, and rejection rights

final column records the aspect over which GRE should not silently assume source-domain authority.

23.16.1 Historical Reconstruction of Economic Processes

GRE requires historical contribution whenever the meaning of a present economic configuration depends on how that configuration was formed. Section 23.4 already established the GRE–GRH interface around historical generation, inherited constraint, path dependence, multiple timescales, contingency, and retrospective re-epistemization. The inward contribution is more specific than the general claim that history matters. Historical inquiry can alter the object being explained, the relevant temporal boundary, the admissible comparison class, and the interpretation of persistence or change.

A current property regime, occupational hierarchy, market category, organizational routine, or pattern of access can look similar across two settings while arising through substantially different sequences of law, conflict, technology, migration, institutional adaptation, or accumulated convention. GRE may describe the present relational configuration, but a formation-sensitive explanation requires evidence about those sequences. Historical reconstruction can therefore correct an economic model that treats an inherited institution as a contemporaneously selected equilibrium, mistakes a contingent sequence for a structural necessity, or chooses a

temporal window too short to identify the process of interest.

Definition 23.371 (Historical reconstruction input). *A historical reconstruction input is a source-supported account of formation, sequence, inherited constraint, temporal scale, contingency, or changing interpretation that modifies the object, mechanism, comparison, or scope of a GRE analysis.*

The contribution remains historically typed after incorporation. GRE can ask how the reconstructed sequence changes an economic explanation, but it should not convert archival interpretation, periodization, or historical significance into an economic conclusion merely because those judgments enter an economic model.

Proposition 23.372 (Formation-sensitive import condition). *For an economic claim whose interpretation materially depends on formation history, present-state evidence alone does not complete the claim; the relevant formation, temporal boundary, and historical contingency require independently warranted historical support.*

This principle also limits formalization. A path-dependent, fast-slow, or multiscale representation can organize an economic question, yet the historical evidence determines whether the chosen state variables, transitions, and rate distinctions correspond to the case. Formal elegance cannot substitute for reconstruction of the historical process being represented.

23.16.2 Governance Requirements for Economic Intervention

GRE can diagnose how an allocation, institution, incentive, infrastructure, or value-conversion interface changes economic relations. Such diagnosis does not by itself determine how collective intervention should be authorized, coordinated, implemented, monitored, revised, or terminated. Sections 23.6 and 23.7 therefore supply a governance interface in which authority structures, institutional learning, response times, uncertainty management, and cross-frequency mismatch can correct an economically attractive intervention that is administratively unavailable or dynamically mistimed.

The inward contribution from governance is especially important when a GRE recommendation presupposes that a public or organizational actor can act coherently. Administrative capacity, jurisdiction, information flow, delegated discretion, inter-agency coordination, implementation sequencing, review procedures, and institutional learning can all mediate whether the proposed economic mechanism is realizable. Governance analysis can also show that an intervention changes the governing system itself. A policy may alter not only prices or resources but also monitoring capacity, trust, institutional workload, participation, or future responsiveness.

Definition 23.373 (Governance realization input). *A governance realization input specifies the authority, coordination capacity, implementation pathway, response horizon, learning mechanism, and uncertainty conditions required for an economically described intervention to become institutionally realizable.*

The contribution changes the status of intervention claims. An economically coherent mechanism may remain a scenario until governance analysis supplies a plausible realization pathway. Conversely, governance evidence may identify a feasible institutional operation that requires GRE to revise its assumed transmission mechanism.

Proposition 23.374 (Intervention realization dependency). *When the expected economic effect of an intervention materially depends on institutional authority, coordina-*

tion, implementation, or response timing, the intervention claim inherits a governance-warrant dependency that should be represented separately from the economic mechanism itself.

This distinction prevents GRE from treating governance as a residual transaction cost. Governance can be constitutive of the pathway through which an economic intervention exists at all.

23.16.3 Legal Categories

Many economic relations are not merely regulated by law after their formation. Legal categories can partly constitute the positions that GRE subsequently analyzes. Section 23.8 showed this for property, contract, legal personhood, rights, duties, institutional recognition, and legal infrastructure. The inward contribution is therefore not limited to adding a legal constraint to an otherwise complete economic relation. It can determine who or what can hold a right, which transfer is valid, which obligation exists, which claim is enforceable, and which institution recognizes the relevant status.

This matters directly for relational allocation and power analysis. Practical control over an asset can diverge from legal title. A contractual arrangement can be economically consequential while its validity, interpretation, or enforceability remains a legal question. A person or organization can have economic capacity without possessing the legal status that a particular transaction, entitlement, or institutional role requires. GRE must retain these distinctions rather than translating them into a single variable of effective control.

Definition 23.375 (Legal-constitutive input). *A legal-constitutive input is a juridically warranted category, status, relation, entitlement, duty, recognition condition, or institutional rule whose legal meaning partly determines the economic positions or transactions represented in GRE.*

The legal contribution can be empirically consequential without becoming economically definable. GRE may study how a legal category redistributes capability, changes bargaining relations, or reorganizes value circulation, while jurisprudence and applicable legal institutions retain authority over the validity and meaning of the category itself.

Proposition 23.376 (Legal-status dependency). *When an economic relation presupposes a legal status or juridical relation, economic evidence about control, exchange, behavior, or consequence cannot by itself establish that legal status; the GRE analysis should preserve the external legal warrant on which the economic representation depends.*

The resulting economic analysis is stronger because its object is more accurately typed. Legal contribution does not narrow GRE to doctrinal analysis; it prevents economic explanation from quietly replacing the legal relations that partly constitute its subject matter.

23.16.4 Political Power

GRE develops a relational account of economic asymmetry and power, but political power requires additional distinctions concerning authority, legitimacy, collec-

tive action, public institutions, recognition, and political membership. Section 23.9 established that an economic asymmetry can become politically relevant without thereby exhausting the political relation. The inward contribution from political theory is therefore corrective at the point where an economic description begins to make claims about public authority, legitimate rule, political standing, or collectively binding decision.

A concentration of resources can condition political influence. Dependence on employment, credit, infrastructure, information, or platforms can reshape bargaining positions and participation. Yet the move from economic leverage to political power is mediated by institutions, public norms, organizational capacities, procedures of authorization, and collective recognition. Political theory can identify these mediations and can also show where apparently economic outcomes are partly generated by prior political settlements.

Definition 23.377 (Political-power correction input). A *political-power correction input* specifies the political institutions, authority relations, legitimacy conditions, collective-action structures, recognition practices, or public decision mechanisms required to interpret an economically observed asymmetry as politically consequential power.

This contribution protects the distinction between power relevance and political-power attribution. It also makes reciprocal constitution visible: economic structures can condition politics, while political authority can constitute property, market access, public infrastructure, taxation, labor rules, and other economic relations.

Proposition 23.378 (Political-power attribution condition). *Economic asymmetry or dependence can support a claim of political relevance, but attribution of political power requires an independently warranted account of the political mechanism through which that asymmetry enters authority, collective decision, public standing, or institutional control.*

GRE should therefore import political distinctions where the economic question crosses into political explanation rather than stretching economic power vocabulary until it contains the political domain by default.

23.16.5 Educational Generativity

Education is a central source of long-horizon capability formation, but its generativity cannot be inferred from expenditure, credential acquisition, labor-market return, or resource provision alone. Section 23.10 identified learning relations, capability generation, curiosity, aesthetic judgment, epistemic participation, educational infrastructure, and knowledge communities as objects requiring educational interpretation. The inward contribution to GRE lies in specifying what kind of learning or developmental transformation has occurred and which relations enable its continuation.

This contribution can revise familiar economic categories. A resource that appears equal in nominal allocation may generate unequal educational possibility because learners differ in language access, time, mentoring, prior preparation, institutional recognition, health of the knowledge community, or capacity to convert the resource into sustained inquiry. Conversely, an educational practice with limited short-run market return may generate curiosity, judgment, interpretive range, or collective epistemic capacity that becomes economically consequential only much later and

through indirect pathways.

Definition 23.379 (Educational-generativity input). An *educational-generativity input* is an educationally warranted account of learning, capability formation, curiosity, judgment, epistemic participation, or knowledge-community reproduction that specifies what developmental change an economic analysis may legitimately treat as generated.

GRE can then study the resources, relations, access conditions, conversion interfaces, and later economic consequences associated with the educational change. It should not replace the educational warrant by treating wages, test outcomes, credentials, or participation counts as universally adequate proxies for learning.

Proposition 23.380 (Resource-to-learning non-deduction). *An observed educational resource allocation or economic return does not by itself establish the kind, quality, or durability of learning generated; a GRE claim about educational generativity therefore requires an independently warranted educational account of the developmental transformation at issue.*

This inward contribution is especially important for the book's broader treatment of generativity. It supplies counterevidence against any tendency to equate later monetizable output with the full value of capability formation.

23.16.6 Ecological Constraint

Economic activity is materially situated within ecological systems whose dynamics are not defined by economic categories. Section 23.11 therefore treated ecological constraint, resource flows, social metabolism, stewardship, intergenerational relations, non-human affected positions, and ecological value as an interface rather than as objects that GRE can fully reconstruct internally. The inward contribution from ecology is strongest where economic feasibility, persistence, or valuation depends on biophysical conditions.

An economic process can appear viable within a monetary or institutional accounting horizon while relying on resource regeneration, waste absorption, climatic stability, biodiversity, ecosystem function, or other conditions whose dynamics are measured and interpreted ecologically. Ecological inquiry can revise the boundary of an economic system, reveal delayed or displaced incidence, and identify conditions under which a resource flow cannot be treated as indefinitely reproducible. It can also challenge a value analysis that counts only humanly monetized manifestations while excluding non-human affectedness or ecological loss.

Definition 23.381 (Ecological feasibility input). An *ecological feasibility input* is an ecologically warranted condition concerning biophysical constraint, regeneration, system interaction, non-human affectedness, ecological value, or intergenerational continuity that materially bounds an economic process or the interpretation of its consequences.

The term *constraint* should be read broadly here. Ecology can contribute limiting conditions, but it can also identify enabling relations, regenerative capacities, thresholds, and coupled processes that an economic account would otherwise omit. The source domain retains authority over the ecological object and its measurement.

Proposition 23.382 (Ecological admissibility dependency). *When an economic scenario materially depends on ecological conditions for its feasibility or persistence, the*

scenario's economic warrant remains conditional on independently supported ecological assumptions; revision of those assumptions requires re-evaluation of the dependent economic claim.

This principle prevents economic optimization from converting an uncertain ecological premise into a fixed background condition merely because the premise lies outside the economic model.

23.16.7 Aesthetic Judgment

Section 23.14 established that aesthetic judgment can influence salience, orientation, curiosity, value formation, cultural participation, and demand while remaining non-equivalent to price or revealed preference. Its inward contribution to GRE is therefore not a supplementary taste parameter. Aesthetic inquiry can correct the way GRE identifies what becomes perceptually salient, what attracts sustained attention, how evaluative standards are learned, and why an object or practice acquires significance before any stable market valuation exists.

This matters for cultural production, design, research orientation, innovation, place-making, education, and other domains in which aesthetic judgment can reorganize attention and possibility. Market manifestations can provide evidence about access, popularity, scarcity, prestige, or willingness to pay. They do not settle whether the relevant aesthetic judgment is warranted, historically informed, cultivated, derivative, contested, or transformed through practice.

Definition 23.383 (Aesthetic-judgment input). An *aesthetic-judgment input* is an aesthetically warranted account of salience, form, orientation, quality, or evaluative discrimination that alters how GRE represents attention, curiosity, valuation, participation, or the generation of later possibilities.

The contribution can also revise causal ordering. Instead of assuming a fixed preference that precedes economic interaction, GRE may need to represent preference, salience, and orientation as historically and relationally formed. Aesthetic theory helps identify which part of that formation is aesthetic rather than economic.

Proposition 23.384 (Market-manifestation non-exhaustion). *Economic manifestations of aesthetic judgment, including price, demand, prestige, and audience size, can inform an economic analysis but do not exhaust the aesthetic warrant or value on which the underlying judgment may depend.*

This inward contribution protects both domains. GRE gains a richer account of orientation and value formation, while aesthetic judgment is not reduced to its economically visible consequences.

23.16.8 Domain-Specific Correction Architecture

The preceding seven contribution classes do not exhaust GRE's external dependencies. Social theory can revise assumptions about institutions, identity, culture, collective meaning, social reproduction, and economic embeddedness, as developed in Section 23.13. Artificial-intelligence studies can revise assumptions about technical capability, model behavior, infrastructure, deployment conditions, verification, or task-relative performance, as developed in Section 23.12. Other domains may become relevant when an economic question depends materially on their objects. The

common requirement is not a fixed list of disciplines but an architecture that makes correction possible.

Domain-specific correction can operate at several levels. It may retype the object under analysis, revise a causal mechanism, narrow an empirical claim, alter a normative evaluation, change a feasible-set assumption, relocate a boundary, or show that an apparently economic category is constituted partly elsewhere. These corrections need not invalidate the whole GRE analysis. They should propagate only through the claims that actually depend on the revised premise.

Definition 23.385 (Cross-domain dependency register). A *cross-domain dependency register* records, for each materially external premise used in a GRE analysis, its source domain, warrant, translation into the economic problem-space, dependent claims, current uncertainty, correction pathway, and revision status.

Definition 23.386 (Domain-specific correction return). A *domain-specific correction return* is a source-domain revision, counterexample, reclassification, measurement update, normative objection, or boundary correction that bears on a premise previously incorporated into GRE and therefore requires review of the economic claims that depend on it.

This architecture also preserves intellectual debt. Once translated into GRE language, an imported distinction can become easy to mistake for an internally generated GRE concept. Recording provenance keeps visible which domain supplied the object, which transformation GRE performed, and which parts of the claim remain answerable elsewhere. Provenance is therefore epistemic as well as scholarly: it identifies where correction can originate.

Proposition 23.387 (Correction-propagation discipline). *When a source-domain premise is materially revised or withdrawn, GRE should re-evaluate the conclusions that depend on that premise in proportion to the dependency; conclusions without that dependency are not thereby invalidated.*

Definition 23.388 (GRE inward-contribution portfolio). A *GRE inward-contribution portfolio* is a maintained set of inward-interface records and dependency registers covering the neighboring-domain premises that materially condition a GRE inquiry, including accepted contributions, contested contributions, rejected translations, unresolved dependencies, and correction returns.

The portfolio complements the outward portability portfolio developed in Section 23.15. Together they prevent interdisciplinarity from becoming a one-way expansion of GRE. GRE can offer analytical structures outward, but it must also remain corrigible by historical evidence, governance knowledge, legal categories, political analysis, educational theory, ecological science, aesthetic judgment, social theory, AI studies, and other domains relevant to the case. The resulting relation is reciprocal without requiring theoretical identity.

Proposition 23.389 (Inward-contribution answerability). *A cross-domain contribution strengthens GRE when its provenance, translation, dependent economic claims, retained source-domain authority, and correction pathway remain explicit enough that the contribution can revise GRE rather than merely be cited by it.*

This inward architecture prepares the next problem in the chapter. Reciprocal borrowing still leaves a difficult semantic question: concepts with the same names can occupy different roles across domains. Relation, subject, value, constraint, power, justice, generativity, institution, and historical specificity therefore require explicit com-

parison before cross-domain recurrence can support any stronger generalization.

23.17 Domain-Specific Semantics of Shared Concepts

Sections 23.15 and 23.16 established reciprocal movement across disciplinary interfaces: GRE can offer portable analytical structures to neighboring domains, and neighboring domains can return premises and corrections that materially revise economic inquiry. Reciprocal movement creates a further problem. The same words recur across economics, history, law, political theory, education, ecology, artificial-intelligence studies, social theory, and aesthetics, yet lexical recurrence does not establish that the words denote the same objects, perform the same inferential work, or carry the same normative authority. The role of the present section is to make that semantic problem explicit before Chapter 23 turns to boundary disputes and possible cross-domain generalization. Its objective is to compare nine recurrent conceptual families—relation, subject, value, constraint, power, justice, generativity, institution, and historical specificity—while preserving the conditions under which their meanings diverge. The method is task-relative conceptual comparison. For each family, the analysis identifies what must be typed locally, what can sometimes be compared structurally, what cannot travel without renewed warrant, and which differences should remain visible rather than being forced into one vocabulary.

The comparison extends the shared-concept profile introduced in Section 23.1. It also adds a stricter distinction between *lexical recurrence*, *structural correspondence*, and *conceptual equivalence*. Two domains can use the same term while sharing little more than a broad family resemblance. Conversely, differently named concepts can preserve a useful structural correspondence for a bounded task. Equivalence is therefore not a property inferred from words alone; it is a claim about a sufficiently specified mapping.

Definition 23.390 (Domain-specific semantic profile). A *domain-specific semantic profile* records, for a recurrent concept in one domain, its object of application, identity conditions, constitutive rules, inferential role, evidential access, normative authority, temporal and spatial scale, relations to neighboring concepts, correction source, and conditions of revision.

Definition 23.391 (Task-relative conceptual equivalence). Two domain-specific concepts have *task-relative conceptual equivalence* only when the semantic dimensions required for a stated cross-domain task correspond sufficiently to support the intended inference, with non-corresponding dimensions and domain-specific remainders recorded explicitly.

The definition deliberately makes equivalence local rather than global. A legal institution and an economic institution can be comparable as durable rule-bearing arrangements for one descriptive task while remaining non-equivalent with respect to validity, authority, membership, sanction, or normative status. An ecological constraint and an economic constraint can both narrow a feasible set while differing in origin, reversibility, observability, and the authority required to modify them. Table 23.17 summarizes the dimensions used below.

Proposition 23.392 (Semantic-equivalence burden). *The burden of a cross-domain equivalence claim lies with the proposed mapping: shared terminology or superficial functional similarity is insufficient unless the dimensions required by the target infer-*

Table 23.17: Comparison dimensions for recurrent concepts across domain interfaces.

Comparison dimension	Guiding question	Typical source of non-equivalence
Object and identity	What is being classified, and what makes it the same object across observations or time?	Different units, memberships, boundaries, or constitutive criteria
Constitutive rule	What makes the concept obtain rather than merely appear?	Legal rule, social recognition, ecological process, pedagogical relation, or economic mechanism
Inferential role	What follows when the concept applies?	Different causal, descriptive, classificatory, or normative consequences
Evidence	How can the claim be warranted or revised?	Different manifestations, methods, records, measurements, or interpretive standards
Normative authority	Who or what can justify the evaluative conclusion?	Domain-specific standards of justice, legitimacy, value, right, stewardship, or quality
Temporal and spatial scale	Over which histories, horizons, places, or relational scales does the concept retain meaning?	Path dependence, rate differences, jurisdiction, ecosystem boundary, or institutional change
Correction source	Which domain can authoritatively challenge the classification or inference?	External expertise, affected positions, doctrine, historical evidence, or domain-specific counterexample

ence are shown to correspond and material remainders are retained.

This burden does not make comparison prohibitively strict. It prevents a local correspondence from silently becoming a universal identity claim. The following subsections apply the discipline to concepts that recur throughout the book and that are plausible candidates for later GR-oriented comparison.

23.17.1 Relation

Relation is the most obvious shared term in a generative relational programme and therefore one of the easiest to overgeneralize. A relation can denote exchange, dependence, obligation, recognition, authority, kinship, pedagogical interaction, ecological coupling, informational dependence, aesthetic orientation, or a formally represented connection. These relations can share structural features while differing in what constitutes the tie, who or what can occupy its positions, what evidence makes it observable, and what consequences follow from its existence.

GRE therefore should not begin a cross-domain comparison by asking whether two domains are “relational.” It should ask which relation is being asserted, between what typed positions, through which mechanism or constitutive rule, over which horizon,

and for which inference. An exchange relation can carry prices and transfers; a legal relation can carry rights and duties; a political relation can carry authority or subjection; an educational relation can organize learning and capability formation; an ecological relation can involve material or biological dependence without human recognition. A common graph can depict each pair as connected while preserving none of those differences by itself.

Definition 23.393 (Typed relation profile). A *typed relation profile* specifies the relation type, constitutive conditions, directionality, symmetry or asymmetry, persistence, scale, observable manifestations, relevant third-party or institutional mediation, and inferential consequences of a relation in its source domain.

Proposition 23.394 (Relational-form non-equivalence). *Similarity in relational form does not establish semantic equivalence when the constitutive conditions or inferential consequences of the relations differ materially across domains.*

This distinction is especially important for formalization. Network, field, category-theoretic, or dynamical representations can preserve selected relational structures while abstracting from legal validity, social meaning, ecological mechanism, pedagogical content, or economic valuation. Such abstraction can be useful, but the formal edge or coupling should not inherit the full semantics of every domain-specific relation it represents.

23.17.2 Subject

Subject terminology carries even heavier domain commitments. An economic subject can be a position whose choices, capabilities, dependencies, or affectedness are relevant to an economic process. Legal personhood depends on juridical recognition and constitutive rules. Political subjecthood can involve membership, participation, representation, standing, or subjection to public power. Educational inquiry may center a learner whose developmental and epistemic participation cannot be reduced to labor-market role. Ecology can require attention to non-human affected positions without settling philosophical or legal subjecthood. AI studies can identify functional agency while leaving consciousness, moral standing, legal personality, and political membership unresolved, as Section 23.12 emphasized.

The recurrent word therefore conceals several distinct questions: who can act, who can be affected, who can bear rights or duties, who can claim reasons, who can participate in collective decisions, who can be represented, and whose future possibilities count within a domain-specific evaluation. One answer does not automatically determine the others.

Definition 23.395 (Subject-status vector). A *subject-status vector* records, for a candidate position, its domain-specific statuses concerning functional agency, affectedness, capability, recognition, legal personality, rights and duties, political membership, epistemic participation, moral standing where relevant, and the evidence or authority by which each status is assigned.

Proposition 23.396 (Subject-status non-propagation). *Assignment of subject status in one domain does not by itself propagate to another domain when the receiving status depends on different constitutive rules, normative warrants, or evidential criteria.*

The vector is not intended as a universal ontology of subjects. It is an interface device for preventing one domain's status from doing unauthorized work elsewhere.

A corporation's legal personality, for example, does not establish sentience; an AI system's task-level functional agency does not establish political membership; ecological affectedness does not by itself settle legal standing. Cross-domain inquiry becomes stronger when such distinctions remain explicit.

23.17.3 Value

Value is central to GRE and simultaneously one of the least suitable concepts for unqualified cross-domain equivalence. Earlier chapters distinguish heterogeneous value forms, conversion, circulation, capture, return, regeneration, and partial or absent commensurability. Chapter 23 has further shown that ecological, educational, legal, political, social, and aesthetic evaluations can enter economic inquiry without receiving their justificatory authority from economics.

The semantic problem is therefore not solved by multiplying value categories inside one economic taxonomy. Aesthetic value may depend on historically cultivated judgment and critical practice. Ecological value can involve integrity, regeneration, non-human affectedness, or stewardship. Legal and political evaluation can concern rights, legitimacy, recognition, or public justification. Educational value can concern learning, capability, curiosity, or epistemic participation. Economic value can concern heterogeneous capacities and consequences within an economic problem-space. These evaluations can interact, conflict, convert imperfectly, or become institutionally linked without becoming one substance measured in different units.

Definition 23.397 (Value-warrant profile). A *value-warrant profile* identifies the object or relation being valued, the evaluative question, relevant subjects or affected positions, source of evaluative reasons, evidential manifestations, comparison procedure if any, conversion conditions, non-commensurable remainder, and the domain that retains authority over the judgment.

Proposition 23.398 (Value-recurrence non-commensuration). *Recurrence of value language across domains does not establish a common metric, a common source of normative authority, or a generally valid conversion rule among the relevant value forms.*

A bounded conversion can still be legitimate. A public institution may assign monetary compensation to an ecological loss, a museum may price access to aesthetic goods, or an educational programme may compare costs with learning outcomes. Such procedures can support decisions while leaving the source value partly unconverted. Practical commensuration should therefore be recorded as an institutional operation, not mistaken for proof of underlying value identity.

23.17.4 Constraint

Constraint appears comparatively neutral, but its semantics also vary. GRE can represent budgetary, infrastructural, institutional, relational, informational, and capability constraints. Historical inquiry can identify inherited constraints whose force depends on path-dependent arrangements. Law can constrain through valid rules, rights, duties, jurisdiction, or enforceability. Political structures can constrain through authority, coercion, agenda control, or dependence. Ecology can impose biophysical limits or regenerative conditions that are not created by economic valuation. Education can constrain or enable learning through access, pedagogical design, time, institutional capacity, and prior capability.

The important distinction concerns *constraint provenance*. Two domains may agree that an option is unavailable while disagreeing about why, how durably, and under whose authority it is unavailable. A model can encode both as a restricted feasible set, but intervention depends on the provenance. A financial limit might change through redistribution or credit; a legal prohibition through lawful institutional change; an ecological threshold might be physically irreversible on the relevant horizon; a historically sedimented constraint can persist even after its original cause disappears.

Definition 23.399 (Constraint-provenance record). A *constraint-provenance record* identifies the constrained position or process, unavailable or costly possibilities, source mechanism, constitutive or causal basis, temporal persistence, scale, reversibility, authority capable of modification where applicable, evidential warrant, and interactions with other constraints.

Proposition 23.400 (Feasible-set non-equivalence). *Two constraints that produce similar observed feasible sets remain non-equivalent for explanation or intervention when their provenance, reversibility, authority, or temporal structure differs materially.*

This proposition protects policy analysis from a common compression. The fact that two mechanisms yield the same short-run choice set does not imply that the same intervention can alter them. Cross-domain constraint analysis should therefore preserve source mechanisms even when a shared formal representation is convenient.

23.17.5 Power

Power has already required careful differentiation within the book. GRE investigates economically relevant power through asymmetry, dependence, control over access and conversion interfaces, concentration of alternatives, institutional position, and the capacity to alter another position's future possibilities. Political theory adds questions of authority, legitimacy, collective action, public institutions, domination, representation, and contestation. Law can constitute or limit powers through rights, duties, jurisdiction, standing, and enforceability. Social theory can locate power in fields, reproduction, cultural classification, identity, status, or symbolic structures. Educational and epistemic relations can generate asymmetries in knowledge, evaluation, credentialing, and participation.

These perspectives can describe one event simultaneously without being redundant. An employer's decision may involve economic dependence, contractual authority, legal constraint, organizational hierarchy, social status, and political regulation. A single generic variable called "power" would conceal which mechanism is doing explanatory work and which domain can challenge the attribution.

Definition 23.401 (Cross-domain power composition). A *cross-domain power composition* records the distinct economic, political, legal, social, epistemic, organizational, or other power mechanisms materially operating in a case, the positions they connect, their sources, manifestations, conversion pathways, limits, and possible interactions without presuming that the mechanisms are instances of one identical relation.

Proposition 23.402 (Power-composition discipline). *When several domain-specific power mechanisms jointly shape an outcome, explanatory adequacy requires preserving their distinct warrants unless a stronger equivalence or derivation among them has been independently established.*

This allows relations among powers to become an object of inquiry. Economic resources can purchase access to political influence; legal authority can stabilize property relations; social status can affect bargaining; epistemic authority can influence institutional decisions. Such conversions and couplings can be studied relationally without collapsing the source mechanisms into one undifferentiated power substance.

23.17.6 Justice

Justice is especially resistant to semantic collapse because the term often marks a justificatory question rather than a descriptive mechanism. GRE can examine distribution, effective options, participation, dependence, capture, conversion opportunities, burden incidence, intergenerational effects, and the generative consequences of institutional arrangements. Those analyses can supply premises to arguments about justice. They do not establish a complete criterion of justice merely by identifying economic asymmetry or generative loss.

Legal justice may involve rights, procedure, standing, remedy, equality before law, or institutional validity. Political justice can involve citizenship, legitimacy, representation, collective self-government, or the distribution of public power. Ecological justice can introduce non-human affectedness, intergenerational responsibility, environmental burdens, and stewardship. Educational justice can concern access, learning relations, capability formation, recognition, and epistemic participation. Different traditions within each domain can also disagree internally about the relevant standard.

Definition 23.403 (Justice-authority profile). *A justice-authority profile identifies the domain-specific object of evaluation, affected positions, candidate principles, empirical premises, source of normative reasons, institutional or practical decision context, conflicts among principles, and the authority and evidence required to revise the judgment.*

Proposition 23.404 (Justice non-derivation condition). *A descriptive diagnosis of asymmetry, dependence, exclusion, inefficiency, or generative loss can be normatively relevant without by itself determining that the arrangement is unjust; the justice judgment requires an explicit normative warrant appropriate to the domain and case.*

The converse also matters. A justified legal or political commitment can constrain economic design even when the resulting allocation is not economically optimal under a narrower criterion. Cross-domain justice analysis therefore coordinates reasons rather than converting every reason into one metric.

23.17.7 Generativity

Generativity is perhaps the most tempting candidate for a shared GR concept because the book repeatedly asks how present relations produce later capacities, structures, meanings, options, or states. Yet the target of generation differs substantially across domains. GRE studies economically relevant generation of capabilities, value forms, relations, institutions, participation, and future possibility. Education concerns learning, curiosity, judgment, and capability formation. Ecology concerns regeneration, reproduction, resilience, metabolism, and coupled environmental processes. Social theory can examine reproduction and transformation of institutions, identity, culture, or

collective meaning. History studies emergence and path-dependent formation across time. Aesthetic practice can generate salience, orientation, forms, and new standards of judgment.

The shared family resemblance is therefore future-forming structure, not a pre-given universal quantity called generativity. Each domain must specify what is generated, through which process, for whom or what, over which horizon, and by what evidence the generation is distinguished from correlation, persistence, transfer, or mere change.

Definition 23.405 (Typed generativity profile). A *typed generativity profile* identifies the source configuration, generated object or capacity, generative mechanism, mediating relations, temporal horizon, affected positions, observable manifestations, counterfactual or comparative basis where available, and the domain-specific criteria by which generation is warranted.

Proposition 23.406 (Generativity target-typing condition). A *cross-domain claim about generativity is informative only when the generated target and the mechanism relating present conditions to that target are typed sufficiently to distinguish generation from persistence, conversion, circulation, reproduction, correlation, or evaluative approval.*

This condition also preserves the distinction between generativity and goodness. A process can generate new capabilities, institutions, dependencies, or forms of coordination while being normatively objectionable. Conversely, a valuable institution may preserve rather than continually generate. Generativity can therefore travel as a disciplined question structure more readily than as a shared evaluative standard.

23.17.8 Institution

Institution is another recurrent label whose apparent familiarity can hide major differences. GRE studies institutions as historically sustained relational configurations that organize allocation, access, conversion, circulation, participation, incentives, expectations, and future possibilities. Law can treat an institution partly through constitutive rules, recognized offices, jurisdiction, procedures, rights, and duties. Political theory can emphasize public authority, legitimacy, representation, and collective decision. Social theory can emphasize norms, roles, fields, reproduction, shared meaning, identity, and patterned practice. Education includes organizations and practices whose institutional form matters for learning relations and knowledge communities. AI-mediated institutions can redistribute operational roles without automatically transferring legal or political authority.

The difficulty is that an institution can be identified through different criteria even within one case. A central bank, university, family, court, market, research community, or platform may have legal, organizational, social, economic, and political dimensions whose boundaries do not coincide. Cross-domain comparison should therefore resist the assumption that one observed organization corresponds to one institution with one stable perimeter.

Definition 23.407 (Institution-constitution profile). An *institution-constitution profile* records the domain-specific rules, practices, roles, memberships, authorities, resources, meanings, infrastructures, reproduction mechanisms, boundaries, and historical conditions through which an institution is identified and sustained for a stated inquiry.

Proposition 23.408 (Institutional-boundary non-coincidence). *Legal, economic, political, social, educational, technical, and other institutional boundaries need not coincide even when the participating domains refer to the same named organization or practice.*

This non-coincidence is analytically productive. It can reveal where authority lies outside ownership, where economic dependence exceeds formal membership, where social norms persist despite legal reform, or where technical infrastructure reorganizes practice without changing formal governance. The institution interface should preserve these cross-cutting boundaries rather than average them into one representation.

23.17.9 Historical Specificity

Historical specificity differs from the preceding eight concepts because it functions partly as an indexing discipline for all of them. Relations, subjects, values, constraints, powers, justice claims, generative processes, and institutions can change their meaning as the surrounding relational structure changes. A category that is adequate in one period can become misleading when transported backward or forward without reconstructing the institutions, vocabulary, practices, technologies, conflicts, and expectations that constituted it.

The problem is not limited to obvious anachronism. Contemporary categories can also obscure historical alternatives by making the present arrangement appear natural or inevitable. Conversely, historical analogy can become too permissive when similarities in surface form are treated as identity despite different infrastructures or institutional meanings. GRH therefore contributes more than chronological context: it supplies a correction against dehistoricized semantic equivalence.

Definition 23.409 (Historical semantic index). *A historical semantic index records the period, place, institutional configuration, relevant vocabulary and practices, technological and material conditions, salient conflicts, evidential sources, and known transformations that condition the meaning and inferential role of a concept in a historical setting.*

Proposition 23.410 (Historical-indexing condition). *A cross-period conceptual comparison is warranted only to the extent that the historical conditions material to the target inference have been reconstructed sufficiently to distinguish preserved structure from semantic, institutional, or practical transformation.*

Historical specificity also constrains claims about a future GRT. If a concept appears across several present-day GR domains, that recurrence may reflect common contemporary institutions, shared scholarly vocabulary, or diffusion among adjacent disciplines rather than a domain-general structure. Comparative evidence becomes stronger when a candidate concept survives both cross-domain and cross-historical variation.

Definition 23.411 (Shared-concept comparison dossier). *A shared-concept comparison dossier is a versioned set of domain-specific semantic profiles, historical semantic indices, proposed task-relative correspondences, translation-loss records, remainders, failed equivalence claims, correction returns, and evidence concerning which conceptual structures persist across domains and periods.*

Proposition 23.412 (Cross-domain semantic answerability). *A claim that a concept is shared across domains is answerable when the relevant domain-specific meanings,*

historical indices, task, proposed correspondence, preserved dimensions, remainders, evidence, and rejection conditions are explicit enough that participating domains can narrow, revise, or reject the claimed equivalence.

These comparisons establish a stricter basis for the remaining Chapter 23 argument. Recurrent vocabulary guides inquiry but does not substitute for comparison. Some concepts may support wider GR formalization; others may remain domain families linked only by partial correspondences. Failed equivalence is informative because it identifies where domain-specific constitution remains material. Section 543 therefore turns to boundary disputes over conceptual ownership, explanatory location, classificatory authority, and the limits of borrowing.

23.18 Disciplinary Boundary Disputes

Section 23.17 established that recurrent vocabulary across domains does not by itself establish conceptual equivalence. The present section addresses the institutional and explanatory consequence of that semantic result. Its role in Chapter 23 is to examine cases in which GRE and a neighboring domain can each make a legitimate claim on the same empirical situation while asking different principal questions, using different warrants, and retaining different correction authorities. The objective is to distinguish productive overlap from disciplinary overreach without assuming that one domain possesses automatic priority. The discussion considers economic–political, economic–legal, economic–social, economic–educational, economic–ecological, and economic–epistemic boundaries before developing a procedure for productive disagreement and boundary revision. The method is jurisdictional and case-sensitive: for each dispute, the analysis asks which object is being explained, which predicates are being asserted, which evidence warrants them, which normative authority is required, and which domain is competent to revise the claim.

A disciplinary boundary dispute need not indicate conceptual failure. It can arise because one event participates simultaneously in several relational structures. A housing policy can be an allocation mechanism, a legal regime, a political decision, a social reproduction process, an ecological intervention, and an epistemic controversy over evidence. The relevant question is therefore rarely which single discipline “owns” the event. The sharper question concerns the jurisdiction of particular claims made about the event.

Definition 23.413 (Disciplinary boundary dispute). A *disciplinary boundary dispute* is a contest over which domain has principal analytical, evidential, classificatory, normative, or revision authority for a stated claim concerning an object that is accessible through more than one disciplinary interface.

Definition 23.414 (Claim-jurisdiction profile). A *claim-jurisdiction profile* records the object under analysis, the predicate asserted of that object, the principal problem-space to which the predicate belongs, the evidence used, the inferential rule applied, any normative warrant required, the neighboring-domain dependencies involved, and the domain or domains authorized to correct the claim.

The claim-jurisdiction profile shifts boundary analysis away from ownership of whole objects. One domain can have principal jurisdiction over one predicate while another domain has principal jurisdiction over a different predicate concerning the same case. GRE may be well placed to analyze how a licensing rule redistributes ac-

Table 23.18: Diagnostic structure of recurrent GRE boundary disputes

Boundary	Typical GRE question	Neighboring-domain jurisdiction	Common overreach risk
Economic–political	Allocation, bargaining position, dependence, conversion interfaces, economic power	Authority, legitimacy, publicness, collective decision, political recognition	Inferring political legitimacy or authority from economic effectiveness or resource control
Economic–legal	Access, control, exchange, liability incidence, enforceability effects	Legal validity, rights, duties, personhood, jurisdiction, doctrinal classification	Treating economic control as legal title or incentive compatibility as legal validity
Economic–social	Economic embeddedness, distribution, reproduction of positions, market incidence	Identity, culture, norms, collective meaning, social reproduction, relational belonging	Reclassifying socially meaningful relations as economic merely because they have economic consequences
Economic–educational	Resource allocation, capability conditions, access, long-horizon economic consequences	Learning, pedagogy, educational aims, developmental quality, epistemic participation	Treating later income or productivity as an exhaustive measure of educational value
Economic–ecological	Resource use, feasibility, externalization, intergenerational allocation, economic value	Biophysical dynamics, ecological integrity, non-human affectedness, ecological value, system boundaries	Converting ecological constraint or value into a price without preserving ecological warrant
Economic–epistemic	Information distribution, knowledge access, research incentives, epistemic labor, capability asymmetry	Truth, justification, evidential quality, expert competence, inquiry norms, correction procedures	Treating market success, attention, possession, or information advantage as epistemic warrant

cess while remaining unable, by economic evidence alone, to establish the legal validity of the license, the political legitimacy of the authority issuing it, or the ecological adequacy of the activity it permits.

Proposition 23.415 (Predicate-specific jurisdiction). *For a cross-domain case, disciplinary jurisdiction is more precisely assigned to specified claims and predicates than to the empirical object as a whole; multiple domains can therefore hold non-identical and simultaneously legitimate jurisdictions over the same object.*

Table 23.18 summarizes the principal boundary-dispute classes considered below. The diagnostic is deliberately asymmetric across columns: the domains can share an object while retaining distinct questions, warrants, and overreach risks.

23.18.1 Economic–Political Boundary

Economic and political analysis overlap strongly where resources affect collective decision and public authority shapes allocation. GRE already treats power as relationally mediated through control over access, conversion interfaces, alternatives, dependencies, and future possibilities. Political theory adds predicates that economic analysis does not independently establish: authority, legitimacy, representation, public standing, political membership, collective obligation, and the justification of binding decisions. A boundary dispute arises when one vocabulary is used to infer the other without the necessary warrant.

Economic resources can alter political feasibility. Wealth can finance organization, media, expertise, litigation, lobbying, campaigning, or sustained participation. Employment dependence, ownership concentration, infrastructure control, and unequal exit options can shape the effective bargaining position of political actors. These are legitimate economic contributions to a political analysis because they identify mate-

rial conditions under which political action occurs. Their presence does not settle whether an actor has lawful or legitimate authority, whether a public decision is justified, or whether a collective procedure constitutes adequate representation.

The reverse direction is equally important. Political decisions can constitute the economic environment by determining taxation, public expenditure, regulation, monetary institutions, public ownership, social insurance, borders of market participation, and the recognized scope of collective provision. GRE can analyze the economic consequences of these decisions, while the political predicates attached to them remain answerable to political theory and relevant public institutions.

Definition 23.416 (Economic–political jurisdiction split). An *economic–political jurisdiction split* distinguishes claims concerning resource-mediated capacities, constraints, dependencies, allocations, and economic power from claims concerning public authority, legitimacy, representation, political membership, and justified collective decision.

A dispute can become especially difficult when the same relation has both economic and political effects. Control of a communication platform, energy network, payment infrastructure, or large employer can produce economic dependence and also alter public discourse or collective bargaining. The proper response is not to force the relation into one domain. The claim-jurisdiction profile should instead identify which mechanism is economic, which predicate is political, and where causal coupling occurs.

Proposition 23.417 (Political-authority non-derivation). *Economic control, efficiency, bargaining strength, or capacity to implement an outcome does not by itself establish political authority or legitimacy; such predicates require political warrants in addition to any economic analysis of the underlying resource relation.*

This condition also protects GRE from the opposite error. A politically legitimate decision can have economically unequal, inefficient, dependency-producing, or capability-reducing consequences that remain proper objects of economic analysis. Political legitimacy therefore does not immunize an allocation from GRE criticism, just as economic performance does not establish political legitimacy.

23.18.2 Economic–Legal Boundary

The economic–legal boundary is constitutive rather than merely adjacent. Property, contract, corporate form, personhood, liability, inheritance, bankruptcy, licensing, labor status, intellectual property, and many other legal categories partly constitute the positions through which economic relations become possible. GRE therefore depends on law in cases where the economic object cannot be adequately typed without a legal classification. At the same time, legal doctrine and institutional recognition have their own criteria of validity that economic analysis cannot replace.

One recurrent dispute concerns property and control. An actor can exercise substantial economic control without holding full legal title, while a legal owner can have limited practical control because of regulation, contractual delegation, fiduciary duty, debt, organizational structure, or dependence on infrastructure controlled elsewhere. GRE can investigate control, access, exclusion, incidence, and downstream generativity. Jurisprudence and positive law determine the legal rights, duties, powers, liabilities, immunities, procedures, and recognized statuses involved.

Contract produces a similar distinction. An exchange can be economically advantageous while legally invalid, unenforceable, voidable, or prohibited. A legally valid contract can also generate severe economic dependence or unequal future capability. Economic analysis can therefore test the relational consequences of a contract without converting those consequences into a conclusion about legal validity.

Definition 23.418 (Economic–legal constitution record). *An economic–legal constitution record identifies the legal categories and institutional acts that constitute an economic position, the economic relations that arise through those categories, the legally authoritative predicates that GRE imports, and the economic consequences that remain available for independent GRE analysis.*

This record is especially important for heterogeneous subjecthood. Economic participation, functional agency, legal personhood, organizational standing, liability-bearing capacity, and ownership eligibility need not coincide. A platform, corporation, automated system, household, association, or informal group can occupy a complex combination of these statuses. The legal interface determines some of them; GRE should not infer the others by analogy.

Proposition 23.419 (Legal-constitution preservation). *When a legal category materially constitutes the economic relation under study, GRE should preserve that legal provenance and should not substitute economic performance, control, incentive compatibility, or observed exchange for the source-domain determination of legal status.*

The boundary remains reciprocal. Legal analysis can also benefit from GRE when formally identical legal categories generate different economic capacities because of unequal resources, information, alternatives, or relational positions. The interface therefore supports mutual correction without collapsing legal validity into economic effect or economic effect into legal validity.

23.18.3 Economic–Social Boundary

The economic–social boundary is difficult because economic relations are commonly embedded in social relations whose meanings exceed exchange or resource allocation. Families, friendships, status groups, professional communities, neighborhoods, religious communities, civic associations, and cultural networks can organize labor, care, trust, access, reputation, information, and opportunity. These consequences make them economically relevant. Their economic relevance does not exhaust their social constitution.

A boundary dispute often appears when an economically consequential social relation is redescribed as a market-like exchange. Reciprocity within kinship, care, friendship, or community can involve resources and expectations, yet the relation may be constituted through identity, obligation, belonging, affection, ritual, history, or collective meaning that cannot be reconstructed from price, contract, or utility alone. GRE can analyze how the relation affects access, capability, distribution, dependence, or future possibility while leaving the social-theoretical remainder intact.

The opposite dispute occurs when social explanation absorbs economic structure. Culture, identity, norms, and collective meaning can shape economic behavior, but they do not eliminate material asymmetries in property, income, bargaining alternatives, infrastructure, or institutional access. Social theory can therefore correct a thin economic account of motivation, while GRE can correct a social account that underrepresents material constraints or conversion mechanisms.

Definition 23.420 (Socially embedded economic object). A *socially embedded economic object* is an economic relation whose operation or meaning materially depends on social identities, norms, institutions, fields, practices, or collective meanings that require independent social-theoretical description.

The social boundary is therefore crossed by specifying the economic predicate rather than by retyping the whole relation as economic. For example, a family relation may be economically relevant because it redistributes care time and income; a professional network may affect job access; a status order may shape consumption or credit. Those predicates can be studied economically while the family, network, or status relation remains a broader social object.

Proposition 23.421 (Economic-incidence non-absorption). *The presence of economically measurable consequences in a social relation is sufficient to motivate an economic interface, but it is not sufficient to absorb the relation's social constitution, identity conditions, meanings, or normative structure into GRE.*

This principle preserves the social relational remainder developed in Section 23.13. It also prevents disciplinary containment from becoming isolation: GRE can remain sensitive to culture, identity, and social reproduction while acknowledging that these objects are not exhausted by their economic incidence.

23.18.4 Economic–Educational Boundary

Education creates economic capabilities and is also a practice with educational aims that exceed later economic output. The boundary dispute therefore concerns the relation between economic conditions of learning and the internal standards by which learning, understanding, judgment, curiosity, participation, and development are evaluated. GRE has legitimate jurisdiction over resource access, opportunity cost, institutional funding, labor conditions, unequal participation, capability conversion, and long-horizon economic consequences. Educational theory retains authority over pedagogical adequacy and educational value where those judgments require educational warrants.

The category of human capital illustrates the problem. Income, productivity, employability, and occupational mobility can capture important economic consequences of education. They cannot by themselves establish whether a learner developed understanding, intellectual autonomy, curiosity, aesthetic or normative judgment, civic capacity, or the ability to participate in knowledge communities. Conversely, educational ideals can be materially constrained by tuition, time poverty, housing, health infrastructure, family responsibilities, labor markets, digital access, and institutional funding. An educational account that ignores these conditions can overstate the practical availability of its own aims.

Definition 23.422 (Economic–educational profile). An *economic–educational boundary profile* separates the economic conditions and consequences of learning from the educational objects, aims, developmental processes, and evaluative standards through which learning quality is judged.

The boundary is especially important for generativity. A learning process can generate later economic capabilities while also generating epistemic, social, civic, aesthetic, or personal capacities. GRE can study one subset of these transformations, including interactions among them, without turning economic realizability into the measure of the others.

Proposition 23.423 (Educational-end non-exhaustion). *Economic outcomes of education can constitute relevant consequences and constraints, yet they do not exhaust the educational ends or developmental qualities of the learning process unless an independently defended educational theory establishes that narrower evaluative scope.*

Boundary disagreement here can be productive because it reveals mismatches between what institutions fund and what education seeks to cultivate. GRE can make the resource structure visible; educational theory can show which valued capacities disappear when economic metrics become the dominant proxy.

23.18.5 Economic–Ecological Boundary

The economic–ecological boundary concerns both feasibility and value. Economic production, consumption, infrastructure, settlement, and trade operate through material and energetic relations whose dynamics are not constituted by economic categories. Ecology can identify system boundaries, regeneration processes, coupled populations, ecological thresholds, non-human affectedness, and long-horizon conditions that constrain economic possibilities. GRE can analyze how institutions allocate access to ecological resources, distribute exposure and risk, shape incentives, mediate conversion, and transmit consequences across subjects and generations.

A boundary dispute arises when ecological objects are translated into economic value. Pricing can be useful for specified decisions, accounting regimes, or policy instruments. A price does not thereby become an exhaustive representation of ecological integrity, non-human standing, irreversible loss, or ecological value. The translation can be pragmatically admissible while leaving a substantial ecological remainder. Conversely, ecological constraint does not itself determine a unique economic distribution or policy. Multiple institutions can respond to the same ecological condition, and GRE can compare their distributive and generative consequences.

Definition 23.424 (Ecological boundary condition for GRE). *An ecological boundary condition for GRE is a source-domain determination concerning biophysical feasibility, regeneration, ecological interaction, system limits, non-human affectedness, or ecological value that materially constrains an economic claim while retaining ecological provenance.*

The distinction matters particularly when economic models treat ecological variables as external parameters. If the ecological process changes endogenously with economic activity, the background condition becomes a coupled relation. GRE can represent the economic side of that coupling, but ecological evidence remains necessary for the ecological dynamics.

Proposition 23.425 (Ecological-warrant preservation). *Economic valuation, optimization, compensation, or institutional design can incorporate ecological information, but these operations do not replace the ecological warrant required for claims about ecological state, regeneration, threshold, integrity, or non-human affectedness.*

The boundary therefore permits partial commensuration without requiring complete commensurability. A policy can use economic instruments while acknowledging ecological constraints or values that remain independently specified.

23.18.6 Economic–Epistemic Boundary

Knowledge and information have economic conditions, yet epistemic warrant is not an economic predicate. Research requires labor, time, institutions, infrastructure, data access, publication channels, education, and often substantial material investment. Information asymmetry, intellectual property, platform control, expert labor markets, and unequal access to computational resources can therefore be legitimate GRE objects. The epistemic domain contributes different questions: whether a claim is supported, whether evidence is adequate, whether an inference is valid, whether expertise is competent, and whether an inquiry process contains credible correction procedures.

The distinction becomes important when economic manifestations are used as proxies for epistemic quality. Market demand for advice, citation advantage, institutional prestige, funding success, information scarcity, or possession of proprietary data can alter epistemic influence without establishing truth or justification. Conversely, a well-supported claim can fail to circulate because of economic constraints on access, attention, language, infrastructure, or institutional participation. GRE can illuminate those constraints while leaving the warrant of the claim to the relevant epistemic and disciplinary standards.

Definition 23.426 (Economic–epistemic jurisdiction split). An *economic–epistemic jurisdiction split* distinguishes claims about the production, access, distribution, control, incentives, labor, and material conditions of knowledge from claims about truth, justification, evidential adequacy, inferential validity, expertise, and epistemic reliability.

AI-mediated inquiry intensifies this boundary. A system can lower the cost of producing candidate explanations, summaries, translations, or analyses while also changing verification burdens, dependence on infrastructure, access to expertise, and the distribution of epistemic labor. These are partly economic questions. Whether an output is warranted remains an epistemic question that cannot be settled by productivity gain alone.

Proposition 23.427 (Epistemic-warrant independence). *Economic success, scarcity, possession, attention, institutional funding, or information advantage can affect the circulation and influence of knowledge claims but does not by itself establish their epistemic warrant.*

The reverse correction is also material. Epistemic findings can alter economic decisions by changing beliefs about risk, feasibility, causation, or expected outcomes. When GRE depends on such findings, the dependency architecture developed in Section 23.16 should preserve the external warrant and its revision pathway.

23.18.7 Boundary Disagreement as Corrective Inquiry

The preceding cases suggest that boundary disagreement can function as a research instrument. A dispute becomes productive when it exposes an untyped predicate, hidden external premise, misplaced normative warrant, missing mechanism, inappropriate proxy, or disagreement about the principal problem-space. The aim of adjudication is therefore not necessarily to assign the case permanently to one discipline. It is to identify which claims require which forms of answerability.

Several disagreement types should be separated. A *semantic dispute* concerns the meaning or identity conditions of a concept. An *explanatory dispute* concerns which

mechanism accounts for the target outcome. A *classificatory dispute* concerns how the object should be typed. An *evidential dispute* concerns what counts as adequate support. A *normative dispute* concerns the authority of a value judgment. A *scope dispute* concerns how far a domain's explanation may travel. A *revision dispute* concerns which source of counterevidence should trigger reconsideration.

Definition 23.428 (Boundary-dispute dossier). A *boundary-dispute dossier* is a versioned record containing the disputed object and claims, participating domains, domain-specific semantic profiles, claim-jurisdiction profiles, evidence and warrants, competing mechanisms, normative dependencies, translation losses, domain-specific remainders, counterevidence, unresolved disagreements, and explicit conditions for revision.

The dossier creates a practical alternative to two unhelpful responses. One response is conceptual imperialism, in which a domain treats its preferred variables or predicates as sufficient for the whole case. The other is disciplinary closure, in which a domain refuses relevant external correction because the evidence was generated elsewhere. A boundary-dispute dossier allows each domain to retain its standards while making the interface inspectable.

Definition 23.429 (Disciplinary overreach). *Disciplinary overreach* occurs when a domain extends a claim beyond the predicates, evidence, constitutive categories, normative authority, or correction competence warranted by its principal problem-space and the explicitly supported translations available at the interface.

Overreach is claim-specific. A domain can legitimately contribute one part of an explanation while overreaching on another. GRE may correctly identify a material dependency and overreach if it concludes that the dependency is politically illegitimate without a political argument. Legal analysis may correctly identify formal rights and overreach if it assumes that formal equality establishes equal economic capability. Educational theory may correctly identify a pedagogical aim and overreach if it treats material access as irrelevant to practical realization.

Proposition 23.430 (Productive-boundary-disagreement condition). *A boundary disagreement becomes analytically productive when it makes the disputed predicates, warrants, dependencies, remainders, and correction authorities more explicit and thereby yields a narrower, better typed, or more revisable account than any participating domain could justify through unexamined extension of its own categories.*

This conception makes disagreement a positive part of the GRE research programme. A failed attempt to assign a phenomenon to one domain can reveal that the phenomenon is genuinely interface-constituted. The resulting explanation can remain plural without becoming incoherent because each component claim retains a specified jurisdiction.

23.18.8 Criteria for Boundary Revision

Disciplinary boundaries are historically formed and should remain revisable, but revisability requires more than a general commitment to openness. A boundary should change when recurrent inquiry shows that the existing division of labor systematically obscures constitutive dependencies, excludes necessary evidence, misclassifies a stable class of objects, or produces repeated translation failures that are better explained by a different interface architecture. Revision can take several forms: expansion of a domain's principal problem-space, creation of a durable interface, recogni-

tion of a hybrid research field, narrowing of an earlier claim, or explicit deference to a neighboring domain.

Boundary revision should also be asymmetric when the evidence is asymmetric. GRE may need to incorporate a legal category without law adopting GRE vocabulary. Ecology may constrain an economic model without ecological inquiry becoming economically defined. A new interface can therefore be important even when conceptual movement is stronger in one direction than the other.

Definition 23.431 (Boundary-revision trigger). A *boundary-revision trigger* is recurrent evidence that an existing disciplinary boundary materially impairs explanation, classification, empirical adequacy, normative answerability, or correction because a stable dependency or object repeatedly crosses the current division of labor.

Not every overlap constitutes such a trigger. Occasional borrowing can remain local. Revision becomes more plausible when the interface recurs across cases, the dependency is constitutive rather than incidental, and participating domains can identify a stable set of questions for which the current boundary produces systematic loss.

Definition 23.432 (Revisable boundary register). A *revisable boundary register* records the current principal problem-space of a domain, recurring interfaces, accepted jurisdiction splits, unresolved disputes, known overreach risks, boundary-revision triggers, rejected expansions, and the evidential basis for later changes in disciplinary scope.

The register prevents revision from becoming silent disciplinary expansion. If GRE extends its scope, the extension should be documented together with the problem that motivated it, the external disciplines involved, the concepts imported or exported, the counterevidence considered, and the claims that remain outside GRE. Such versioning is especially important for a young research programme whose boundaries are still being formed.

Proposition 23.433 (Boundary-revision discipline). A *disciplinary boundary* is responsibly revised when the proposed change responds to recurrent interface evidence, preserves the independent warrants that remain outside the domain, states the new jurisdiction with sufficient precision, and remains open to reversal or further narrowing if subsequent cases fail to support the expansion.

Proposition 23.434 (Cross-domain jurisdiction answerability). A *cross-domain claim* is jurisdictionally answerable when its object, predicate, principal problem-space, evidential and normative warrants, external dependencies, participating correction authorities, overreach conditions, and boundary-revision implications are explicit enough for the affected domains to contest or revise the allocation of explanatory responsibility.

These disputes also provide comparative evidence for the next section's assessment of the conditions under which any future Generative Relational Theory could be generalized responsibly.

23.19 Cross-Domain Generalization Criteria

Sections 23.15–23.18 established a two-way interface architecture: GRE can offer portable analytical kernels, receive externally warranted corrections, preserve domain-specific semantics, and revise disciplinary boundaries when recurrent evidence justifies doing so. The present section asks what, if anything, can be inferred

at a higher level from such cross-domain comparison. Its role in Chapter 23 is to specify the evidential discipline required before recurrent structures in GRE, GRH, GRG, law, political theory, education, ecology, aesthetics, social theory, AI studies, or other prospective domains are treated as candidates for a more general Generative Relational Theory (GRT). The objective is neither to construct GRT in this book nor to deny the possibility of a future general theory. It is to distinguish domain instantiation, recurrent structure, candidate invariance, counterexample, and justified generalization so that later work can assess general claims without converting shared vocabulary into evidence by assumption. The method is comparative and adversarial: candidate structures are evaluated through independent domain reconstruction, semantic typing, historical variation, failed translation, non-transferable assumptions, and counterexamples before any broader scope is assigned.

The principal difficulty is that the present domains are not statistically independent observations. Several were formulated through a partially shared GR vocabulary. If relation, generation, constraint, difference, subjecthood, value, power, or historical dependence are intentionally carried into more than one domain, their recurrence can reflect common intellectual ancestry rather than discovery of a domain-transcending structure. Cross-domain comparison therefore requires a distinction between recurrence that was built into the domains and recurrence that reappears after domain-specific inquiry has been allowed to transform, reject, or reconstruct the inherited concept.

Definition 23.435 (Cross-domain generalization problem). The *cross-domain generalization problem* is the problem of determining which structures observed across several domain theories can responsibly be assigned a broader scope, given differences in semantic constitution, evidence, methods, histories, normative authority, and the possibility that apparent recurrence reflects shared theoretical ancestry.

Definition 23.436 (Shared-origin confound). A *shared-origin confound* arises when recurrence across domains is partly produced by common inherited concepts, modeling choices, or foundational assumptions, so that the recurrence cannot be treated as independent evidence for the generality of the repeated structure.

This confound does not make cross-domain comparison uninformative. It changes what the comparison can establish. A structure that survives domain-specific reconstruction, loses some inherited features, acquires new semantics, encounters counterexamples, and nevertheless remains useful across several independently warranted problem-spaces provides stronger evidence than a structure repeated verbatim because each domain was instructed to use the same vocabulary.

Proposition 23.437 (Generalization-burden principle). *Broader GR claims require stronger comparative evidence: independently reconstructed cross-domain recurrence supports more generality than single-domain or shared-origin recurrence, especially when it survives historical variation, failed translation, and counterexamples.*

Table 23.19 summarizes the evidential ladder used throughout this section.

23.19.1 Domain Instantiations

The appropriate starting point for generalization is a set of domain instantiations rather than a presumed universal template. GRE, for example, develops relational allocation, heterogeneous value, conversion, circulation, generative capacity, power over interfaces, historical economic structure, and economic spacetime because these

Table 23.19: Evidential ladder for cross-domain generalization toward a future GRT

Status	What has been observed	Additional burden before stronger scope is justified	Permissible interpretation
Domain instantiation	A structure is useful within one principal problem-space	Local semantic, evidential, historical, and methodological adequacy	Domain-specific construction
Designed recurrence	Similar vocabulary or structure appears in several domains through shared inheritance	Independent reconstruction and explicit control for common ancestry	Comparative prompt, not general evidence by itself
Discovered recurrence	A related structure reappears after domain-specific reconstruction	Typed correspondence, translation-loss analysis, and counterexample search	Candidate cross-domain pattern
Historically robust recurrence	The candidate survives materially different historical or institutional settings	Scope conditions, failure cases, and mechanism or structural rationale	Conditional candidate invariant
General-theory candidate	The structure survives heterogeneous domains, histories, methods, and adverse cases with explicit limitations	Continued testing in new domains and openness to revision or rejection	Provisional GRT-level hypothesis

objects answer economic questions. A legal domain can require validity, rights, duties, jurisdiction, recognition, and personhood. An educational domain can require learning, pedagogy, capability formation, curiosity, and epistemic participation. An ecological domain can require biophysical processes, ecological integrity, non-human affectedness, metabolism, and intergenerational constraint. Similar relational language can occur in each domain while the objects and warrants remain different.

A domain instantiation should therefore be understood as a theory constructed under a principal problem-space, not as a local example of a general theory whose full form has already been settled. This ordering matters. If a general architecture is specified first and domains are subsequently required to instantiate it, cross-domain agreement can become circular. If domains are allowed to develop from their own problems, evidence, methods, and correction authorities, later comparison can reveal which inherited structures survived genuine reconstruction.

Definition 23.438 (GR domain instantiation). A *GR domain instantiation* is a domain-specific theoretical construction that uses only those GR resources that remain analytically defensible for its principal problem-space and supplements, modifies, or rejects them according to domain-specific objects, evidence, methods, histories, and correction authorities.

This definition places domain autonomy inside the evidence for future generalization. A domain that cannot reject an inherited GR concept cannot provide strong evidence that the concept is genuinely general. The possibility of divergence is therefore methodologically valuable. Domain-specific modification, non-translation, and even

rejection can help separate indispensable structure from inherited convenience.

Definition 23.439 (Domain-independence gradient). A *domain-independence gradient* records how far a domain's relevant concepts and results were independently reconstructed from its own problem-space, evidence, and methods rather than inherited unchanged from a shared GR vocabulary.

The gradient need not be binary. GRE and GRH can share more intellectual ancestry than GRE and an independently developed ecological or jurisprudential framework. Cross-domain evidence should therefore be weighted qualitatively by the degree of independent reconstruction rather than counted as though each domain were an independent replication.

Proposition 23.440 (Domain-autonomy contribution). A *domain contributes stronger comparative evidence to a future GRT when its relevant structures can be justified from the domain's own problem-space and remain open to rejection or substantial transformation of inherited GR vocabulary.*

23.19.2 Candidate Invariants

The word *invariant* requires restraint in this context. In mathematics and physics, invariance can have precise meanings relative to specified transformations. Cross-domain theory comparison usually operates with weaker evidence. A recurring conceptual or structural relation should therefore be called a *candidate invariant* only when the relevant transformation or variation has been stated. The candidate might concern persistence across domain translation, historical change, changes of representation, methodological access, or institutional setting. Each is a different claim.

For example, the book's sparse primitives of change, structure, constraint, and difference may appear useful across several domains. Their recurrence is suggestive, but it does not yet establish that they are metaphysically fundamental or sufficient for every prospective GR domain. Their current status is better understood as low-assumption analytical starting points whose adequacy can be tested through domain construction. Similarly, the recurrence of relational dependence, path-sensitive generation, asymmetric access, or heterogeneous manifestation can motivate comparison without establishing universal validity.

Definition 23.441 (Candidate cross-domain invariant). A *candidate cross-domain invariant* is a structure, relation, distinction, or constraint that remains identifiable under a specified class of domain, historical, methodological, or representational variations after domain-specific semantics and translation losses have been taken into account.

The phrase “remains identifiable” is intentionally weaker than “remains identical.” Section 23.17 showed that relation, subject, value, power, institution, and generativity can recur while changing semantic constitution. A future GRT candidate may therefore preserve a higher-order relation among typed objects even when the objects themselves are non-equivalent. Such preservation must be demonstrated rather than inferred from shared words.

Definition 23.442 (Invariance specification). An *invariance specification* states the candidate structure, the class of variations under which persistence is claimed, the domain-specific semantics that may change, the features required to remain stable, the evidence used to identify persistence, and the observations that would count as

failure.

Proposition 23.443 (Specified-variation condition). *A cross-domain invariance claim is interpretable only relative to a stated class of variations and a stated persistence criterion; recurrence without these specifications remains a similarity observation rather than an invariant claim.*

23.19.3 Recurrent Structures

Cross-domain comparison can still be productive before invariance is established. Recurrent structures occupy an intermediate status. They are patterns that appear in multiple domains with enough typed correspondence to justify comparison, while their generality remains unsettled. Examples suggested by the present book include historically conditioned relations, constraints on feasible transformation, differential access to generative possibilities, conversion among heterogeneous forms, dependence on relational position, and the role of mediation in turning one capacity into another.

The central methodological distinction is between *designed recurrence* and *discovered recurrence*. Designed recurrence arises when a concept appears across domains because it was intentionally imported from the common framework. Discovered recurrence arises when domain-specific inquiry reconstructs a comparable structure for reasons that are independently warranted within each domain. Most early GR research will contain mixtures of the two. The task is to document the mixture rather than to classify every case as purely one type.

Definition 23.444 (Designed recurrence). *Designed recurrence* is cross-domain similarity produced materially by deliberate reuse of a shared conceptual, formal, or methodological resource.

Definition 23.445 (Discovered recurrence). *Discovered recurrence* is cross-domain similarity that remains after participating domains independently reconstruct the relevant object or relation from their own evidence, problems, and correction standards and are permitted to alter or reject the inherited formulation.

A discovered recurrence need not be surprising in order to be evidentially stronger. The point concerns warrant rather than psychological novelty. If legal, ecological, educational, and economic inquiry each require a distinction between formal status and practical accessibility for different reasons, the recurrence can be theoretically important even if researchers anticipated it. Conversely, repeated use of the word “relation” is weak evidence when each domain inherited relational vocabulary from the same source without an independent adequacy test.

Definition 23.446 (Recurrent-structure comparison record). *A recurrent-structure comparison record* documents the participating domains, local definitions, independent grounds for reconstruction, shared-origin dependencies, typed correspondences, translation losses, historical variation, non-equivalent predicates, observed failures, and the current evidential status of the proposed recurrence.

Proposition 23.447 (Recurrence-evidence condition). *Cross-domain recurrence provides stronger evidence for a broader GR structure when the recurrence survives independent reconstruction, semantic retyping, and exposure to domain-specific failure conditions rather than arising principally from unchanged inheritance.*

23.19.4 Domain-Specific Failures

Failure is especially informative for a comparative programme. A concept can work well in GRE and fail in law because legal validity does not reduce to effective control. A participation concept can work economically and fail politically if it does not capture representation or public authorization. A generative-value description can illuminate economic conversion while remaining inadequate for aesthetic value or ecological integrity. These failures do not necessarily refute the domain theory that generated the concept. They delimit the scope of the proposed cross-domain transfer.

The relevant question is therefore not whether a concept has a failure case in some neighboring domain. Many useful concepts should. The question is what the failure teaches about the architecture of the concept. A failure may reveal an economic premise, a human-centered assumption, a requirement of commensurability, a hidden legal status, a temporal scale, a specific institutional form, or a normative warrant that had been treated as if it were general.

Definition 23.448 (Domain-specific generalization failure). A *domain-specific generalization failure* occurs when a candidate cross-domain structure loses explanatory adequacy, semantic coherence, evidential support, or normative answerability in a receiving domain for reasons traceable to that domain's constitutive features rather than to a merely terminological mismatch.

Definition 23.449 (Failure-extraction record). A *failure-extraction record* identifies the failed transfer, the domain in which it failed, the constitutive feature producing the failure, the assumption exposed by the failure, the portion of the candidate structure that remains usable, and the resulting restriction or revision of the broader claim.

This record turns negative results into constructive theoretical evidence. If a structure survives only in domains with exchangeable value forms, the resulting theory should state that scope. If it survives only where subjects are legally recognized persons, that dependency should be visible. If it fails when system boundaries are bio-physical rather than institutionally defined, the difference can guide later abstraction.

Proposition 23.450 (Failure-information principle). A *well-characterized domain-specific failure can strengthen a future general theory by revealing the conditions under which a candidate structure ceases to travel and thereby narrowing, retyping, or decomposing an overbroad generalization.*

23.19.5 Non-Transferable Assumptions

Some cross-domain failures arise from assumptions that are useful within one domain and inappropriate outside it. GRE, for example, can legitimately use prices, budgets, ownership, exchange, production, income, or institutionalized economic scarcity in analyses where those categories are empirically relevant. None should be silently carried into ecology, aesthetics, law, education, or political theory as though it were part of GR itself. The same caution applies in the reverse direction: legal personhood, political citizenship, ecological integrity, educational achievement, or aesthetic judgment are not general GR primitives merely because they matter at an interface with economics.

Non-transferable assumptions can be substantive, methodological, formal, or normative. A substantive assumption concerns the kind of objects present. A

methodological assumption concerns which observations and evidential procedures are available. A formal assumption concerns mathematical structure such as metricity, continuity, closure, reversibility, scale separation, or comparability. A normative assumption concerns what counts as improvement, justice, legitimacy, value, or acceptable intervention. Each can generate false generality when left implicit.

Definition 23.451 (Non-transferable assumption). A *non-transferable assumption* is an assumption that is warranted within a source domain or modeling context but lacks independent warrant in one or more receiving domains and therefore cannot be included in a broader GR claim without additional argument.

A future GRT should consequently be thinner than the aggregate vocabulary of its domains. Generalization usually requires subtraction before synthesis: remove domain-specific assumptions, preserve the remainder only if it continues to carry analytical content, and then test whether that remainder can be reconstructed in domains that did not generate it.

Definition 23.452 (Generalization residue). A *generalization residue* is the portion of a candidate cross-domain structure that remains after domain-specific assumptions, unsupported semantic carryover, and non-transferable normative or methodological commitments have been removed.

The residue can become too thin to be useful. That outcome is theoretically legitimate. A statement such as “contexts contain differences and changes” may survive almost every domain but explain very little. Generality and analytical fertility are therefore separate dimensions. A future GRT needs sufficiently broad scope and sufficient structure to generate discriminating questions, while avoiding the reintroduction of domain-specific assumptions merely to regain explanatory richness.

Proposition 23.453 (Generality-content discipline). A *candidate GRT structure should be evaluated separately for breadth of admissible scope and for analytical content; removal of domain-specific assumptions can increase portability while simultaneously reducing explanatory discrimination.*

23.19.6 Cross-Domain Counterexamples

Counterexamples deserve a stronger role than routine limitations language. A candidate general structure should be tested against domains and cases selected because they are likely to strain its assumptions. If a framework was developed mainly from human institutions, non-human ecological relations can provide an adverse case. If it relies heavily on stable institutional identity, rapidly changing AI-mediated configurations can test the assumption. If it was developed in modern market settings, historical cases with different property, monetary, legal, or political arrangements can test historical dependence. If it presumes coherent subjects, collective, distributed, fragmented, or ambiguous agency can provide counterevidence.

Cross-domain counterexamples can take several forms. A *semantic counterexample* shows that a recurrent term lacks a stable enough higher-order correspondence. A *constitutive counterexample* shows that the object exists through a different kind of constitutive relation. A *mechanism counterexample* shows that similar manifestations arise through materially different processes. A *normative counterexample* shows that a proposed evaluative extension lacks authority. A *historical counterexample* shows that the structure depends on a specific institutional period. A *formal counterexample* shows that a mathematical assumption such as continuity, metricity, closure, equilib-

rium, or separable scale fails in a relevant domain.

Definition 23.454 (Cross-domain counterexample). A *cross-domain counterexample* is a case from a relevant domain, history, or methodological setting that satisfies the proposed scope of a candidate general claim but fails one or more of its required structural, semantic, evidential, formal, or normative conditions.

The definition distinguishes a counterexample from an excluded case. A theory can responsibly limit its scope. The stronger test arises when a case appears to fall within the claimed scope and nevertheless violates the proposed structure. Scope narrowing after such a case is legitimate when the new boundary has substantive justification and is recorded as a revision rather than introduced only to protect the theory from falsification.

Definition 23.455 (Adversarial comparison portfolio). An *adversarial comparison portfolio* is a deliberately heterogeneous set of domains, histories, institutional forms, subject configurations, scales, and methodological access conditions selected to test the assumptions most likely to fail in a candidate cross-domain generalization.

Proposition 23.456 (Counterexample priority). *For a proposed expansion in theoretical scope, a well-matched counterexample can carry greater revisionary significance than several confirmatory cases whose agreement is partly explained by shared vocabulary, common institutional history, or related modeling assumptions.*

23.19.7 Conditions for Generalization

The preceding distinctions permit a more disciplined account of generalization. A future GRT claim should be supported by more than breadth of vocabulary. At minimum, the proposed structure should be locally adequate in several domains; reconstructed with meaningful domain independence; semantically typed; robust to relevant historical variation; explicit about non-transferable assumptions; tested against failed translations and adverse cases; and narrow enough that its correction conditions can be stated. The evidential base should also include domains whose methods and objects differ materially from those in which the candidate was first formulated.

Generalization should remain modular. Some structures may generalize farther than others. The primitive distinction among change, structure, constraint, and difference could eventually receive broader support than specific claims about subjects, value, power, institutions, fields, or spacetime. A future GRT need not therefore emerge as one indivisible package. It may consist of layers with different evidential maturity, domain range, and dependence on stronger assumptions.

Definition 23.457 (Cross-domain generalization dossier). A *cross-domain generalization dossier* is a versioned record containing the candidate structure, participating domain instantiations, domain-independence gradients, local semantic profiles, designed and discovered recurrences, invariance specifications, historical tests, translation losses, non-transferable assumptions, generalization residues, domain-specific failures, cross-domain counterexamples, rejected formulations, current scope conditions, and explicit revision triggers.

The dossier gives a future GRT programme a cumulative memory. A claim that survives three domains today can later be revised when a fourth domain exposes a hidden assumption. A generalization narrowed after a historical counterexample can retain the earlier failed version as evidence about why the boundary changed. This

form of versioning is compatible with the broader GRE commitment to research as a revisable, historically situated practice.

Proposition 23.458 (Conditional generalization criterion). *A recurrent GR structure becomes a defensible candidate for broader generalization when its cross-domain correspondence is independently warranted, its semantic and historical variations are explicit, relevant failures and counterexamples have been sought, non-transferable assumptions have been removed or scoped, and the remaining claim retains enough analytical content to generate contestable consequences.*

Proposition 23.459 (Modular maturity principle). *Different components of a prospective GRT can justifiably remain at different levels of evidential maturity; support for one recurrent structure does not automatically transfer to other GR concepts that have not survived comparable cross-domain testing.*

23.19.8 General-Theory Restraint

The present book does not provide the evidential base required to claim a completed GRT. It develops GRE as the principal domain, uses preliminary GR foundations sufficient for that task, and examines a limited set of neighboring interfaces. Several of those neighboring domains are represented only through interface questions rather than mature, independently developed domain theories. The comparative sample is therefore theoretically informative but too dependent, too historically concentrated, and too incomplete to warrant a universal synthesis.

General-theory restraint is consequently a methodological commitment rather than rhetorical modesty. Premature synthesis can make later domain work less informative because researchers may begin fitting evidence to the announced general structure. It can also obscure failed translations by redescribing them as special cases of an increasingly flexible theory. A research programme gains more from a candidate that can fail clearly than from a vocabulary capable of absorbing every outcome after reinterpretation.

Definition 23.460 (Premature generalization). *Premature generalization* occurs when a cross-domain claim is assigned broader theoretical scope than is supported by independent domain reconstruction, semantic typing, historical variation, explicit assumption control, and available counterevidence.

Definition 23.461 (Provisional GRT candidate). *A provisional GRT candidate* is a cross-domain structure whose current evidence justifies testing beyond its source domains while its universality, ontological status, and final theoretical form remain explicitly unsettled.

The distinction between a provisional candidate and a general theory preserves room for ambitious inquiry. Researchers can formulate broad conjectures, compare structures, construct formal representations, and search for invariants without presenting the resulting architecture as settled. The appropriate next step after a promising recurrence is therefore wider and more adversarial testing, including domains whose objects, histories, methods, and normative structures make agreement difficult rather than likely.

Proposition 23.462 (Future-GRT research discipline). *A future GRT is more responsibly approached as the revisable outcome of comparative domain research than as a template imposed in advance on domains whose independent development is still incom-*

plete.

Proposition 23.463 (Cross-domain generalization answerability). *A prospective GRT claim is cross-domain answerable when its source domains, shared-origin dependencies, comparison dimensions, invariance specifications, non-transferable assumptions, counterexamples, historical limits, current scope, and revision conditions are explicit enough for later domains to confirm, narrow, decompose, or reject the proposed generalization.*

The resulting position is intentionally open. Chapter 23 has shown that relational interfaces can connect disciplines without erasing their differences, and the present section shows how those differences become evidence rather than obstacles in the search for broader structure. The immediate task for GRE remains more local: its own explanatory scope, partial explanations, deferrals, and claims that should remain outside the domain must be stated before the chapter can close responsibly.

23.20 Explanatory Scope of GRE

Chapter 23 has developed disciplinary interfaces, translation rules, reciprocal correction, concept-specific semantics, boundary-dispute procedures, and criteria for cross-domain generalization. The chapter can close only by applying those disciplines reflexively to Generative Relational Economics (GRE) itself. The role of the present section is therefore to state the kinds of claims for which GRE can presently bear primary explanatory responsibility, the kinds it can address only partially, the points at which it must defer to neighboring domains, and the claims that remain outside its warrant. The objective is not to create an impermeable disciplinary border. It is to make GRE's current scope answerable: a reader should be able to identify why a question is economic, which premises come from elsewhere, what evidence could revise the boundary, and which unresolved limitations should become explicit research problems rather than being hidden by broad relational vocabulary. The method is claim-centered and provenance-preserving. Scope is assigned to particular explanatory predicates and warrants rather than to whole empirical objects, and boundary revision remains possible when domain counterevidence accumulates.

This reflexive task follows directly from Sections 23.15–23.19. GRE can contribute portable analytical kernels without universalizing them, can import externally warranted premises without appropriating their source authority, can preserve non-equivalent meanings across domains, can share empirical objects without claiming exclusive jurisdiction, and can treat failed generalization as evidence. The same discipline implies that GRE should not infer explanatory authority merely because an object has economic consequences. A school, watershed, court, family, AI system, artwork, political institution, or historical event can be economically consequential while requiring educational, ecological, legal, social, technical, aesthetic, political, or historical explanation for features that GRE does not constitute or warrant.

Definition 23.464 (GRE scope condition). *A GRE scope condition is a stated condition under which an economic claim falls within GRE's direct explanatory domain, partial explanatory reach, domain-deference architecture, or current non-claim space, together with the evidence, assumptions, correction sources, and revision triggers relevant to that assignment.*

Definition 23.465 (GRE explanatory-scope profile). *A GRE explanatory-scope profile*

Table 23.20: Scope statuses for GRE claims at disciplinary interfaces.

Scope status	GRE responsibility	Typical condition	Required discipline
Direct explanation	Bear primary responsibility for the economic predicate and its warrant	Principal question concerns economically constituted relations, allocations, capabilities, value processes, institutions, or economic power	State mechanism, evidence, historical scope, and correction conditions
Partial explanation	Explain an economic component of a mixed-domain object or process	Economic mechanism is material but not sufficient to constitute the full object or conclusion	Mark the remainder and identify the additional domain warrants required
Domain deference	Use a premise whose validity is warranted principally outside GRE	Legal validity, political legitimacy, ecological integrity, educational quality, aesthetic judgment, technical capability, or another external status is material to the economic conclusion	Preserve provenance and revise dependent GRE claims when the external premise changes
Current non-claim	Decline to present GRE as warranting the predicate	The claim concerns ultimate ontology, domain-specific normativity, subject status, validity, quality, or universality beyond available evidence	Keep the question open, transfer it to the appropriate domain, or formulate only a conditional economic consequence

records for a claim its principal problem-space, economically typed objects and relations, mechanism or constitutive pathway, evidential basis, external premises, normative dependencies where present, current scope status, neighboring correction authorities, and conditions under which the status should be revised.

Table 23.20 summarizes the four statuses used throughout the section. They are not ranks of intellectual importance. They describe different distributions of explanatory responsibility.

Proposition 23.466 (Scope answerability). *A GRE claim is scope-answerable when its economic predicate, evidential warrant, external dependencies, domain remainders, and revision conditions are explicit enough for another inquiry to confirm the claim, narrow it, retype it, transfer part of it to a neighboring domain, or reject it without*

requiring rejection of unrelated GRE claims.

The proposition makes scope a property of accountable inquiry rather than a defensive boundary. A theory with no way to say where its authority weakens cannot learn reliably from neighboring domains. Conversely, a theory that treats every external dependency as evidence that economics has nothing to contribute would surrender precisely the relational interactions that GRE is designed to study. The relevant task is to type explanatory responsibility carefully.

23.20.1 Primary Explanatory Domain

GRE's primary explanatory domain is defined by its principal economic problem-space rather than by a closed list of empirical objects. The framework is most directly concerned with how economic positions, resources, capabilities, access conditions, allocations, institutions, value forms, conversion interfaces, circulation pathways, dependencies, and historically structured constraints participate in the generation or contraction of later economic possibilities. The object can be a household, firm, platform, public institution, educational setting, ecological intervention, legal arrangement, or AI-mediated workflow. What makes the claim directly economic is not the object's label but the predicate being explained and the mechanism through which that predicate is constituted.

This distinction is important because GRE was developed to move beyond an economy imagined as already-given agents exchanging already-given resources. Earlier chapters treated allocation as relational intervention, value as heterogeneous and capable of conversion, circulation, capture, return, dissipation, and regeneration, economic subjects as historically positioned rather than metaphysically fixed, and economic structures as capable of altering future capacities and option spaces. These remain economic objects when their constitutive questions concern access, feasible action, resource control, production, allocation, exchange, conversion, circulation, participation, dependence, economic power, or the generation of economically relevant capabilities.

Definition 23.467 (Economic explanatory target). An *economic explanatory target* is a typed claim about an allocation, access condition, resource relation, capability, value process, economic institution, economic dependency, conversion or circulation interface, economically relevant participation, or historically structured economic possibility whose constitution or change can be investigated with economic evidence and mechanisms.

The definition intentionally avoids equating “economic” with monetary. A non-priced care relation can contain an economic explanatory target when it structures labor availability, material dependence, capability, access, or resource allocation. A public archive can become economically relevant when funding, access infrastructure, property arrangements, or labor conditions shape who can use it and what later capabilities become feasible. Conversely, a priced artwork does not become exhausted by economic explanation merely because exchange produces a monetary manifestation.

Definition 23.468 (Direct GRE explanation). A *direct GRE explanation* is an explanation for which the principal explanandum is an economic explanatory target and the decisive constitutive or generative mechanism can be warranted predominantly through economically typed relations, evidence, and historically situated institutional

conditions without an unresolved neighboring-domain premise being required to establish the target itself.

Direct explanation can still use interdisciplinary evidence. Historical records, legal documents, ecological measurements, technical audits, or interviews can be indispensable manifestations of an economic process. Their use does not by itself make the explanation partial. Partiality arises when the conclusion depends on a predicate whose constitution or warrant remains principally external to GRE. A historical record showing that access to credit changed after a legal reform can support an economic explanation of changed financing conditions; a further conclusion that the reform was legally valid or politically legitimate requires different authority.

GRE is particularly well positioned to study several classes of direct target. One is *relational allocation*: who or what is enabled, constrained, connected, displaced, or made dependent when resources and opportunities are allocated. Another is *heterogeneous value process*: how value forms are generated, translated, converted, circulated, captured, returned, dissipated, or regenerated without presuming a universal common measure. A third is *generative economic capacity*: how present interventions change the later ability of persons, organizations, communities, or infrastructures to participate in economic processes or generate subsequent possibilities. A fourth concerns *economic power*: control over access, conversion, circulation, recognition interfaces, and the feasible transformations available to other positions. A fifth concerns *historically structured economic dynamics*: path dependence, multiscale timing, institutional persistence, and the conditions under which an economic configuration becomes self-sustaining or difficult to revise.

Proposition 23.469 (Principal-problem criterion). *An empirical object can fall within GRE's direct explanatory scope for one predicate while remaining outside it for others; direct scope is justified by the principal economic problem and its warrant, not by disciplinary ownership of the object as a whole.*

The criterion preserves the predicate-specific jurisdiction developed in Section 23.18. A university can be directly analyzed as an employer, allocator of research resources, producer of credentials with economic consequences, or infrastructure for capability generation. The same university also contains pedagogical, legal, political, social, aesthetic, and epistemic objects whose constitution is not settled by the economic account. Direct economic explanation therefore coexists with domain plurality rather than displacing it.

Proposition 23.470 (Economic-incidence restraint). *The presence of economic consequences is insufficient to establish that the full constitution, meaning, quality, validity, legitimacy, or value of the affected object lies within GRE's direct explanatory scope.*

23.20.2 Partial Explanatory Reach

Many important GRE questions are neither purely internal nor merely deferred. They concern mixed-domain processes in which an economic mechanism explains a material part of the outcome while other domains are required to explain what the object is, why a status obtains, or how a conclusion should be evaluated. Partial explanation is therefore not a defect to be hidden. It is a positive scope category that permits GRE to contribute without representing its contribution as complete.

Consider educational capability. GRE can analyze unequal access to time, digital infrastructure, mentoring, housing stability, income, or institutional resources that

shape whether learning opportunities can be realized. It can also study how educational capability affects later economic participation. Those analyses do not establish educational quality, pedagogical adequacy, or the meaning of learning. Similarly, GRE can analyze how property rights, liability rules, or contractual classifications alter feasible economic relations while leaving questions of legal validity and doctrinal interpretation to law. In ecology, GRE can investigate resource extraction, externalized costs, livelihood dependence, investment incentives, and intergenerational allocation while ecological science and ethics retain independent authority over ecosystem dynamics, ecological integrity, non-human affectedness, and environmental value.

Definition 23.471 (Partial GRE explanation). *A partial GRE explanation identifies and warrants an economically material mechanism, relation, or consequence within a broader explanandum whose adequate constitution or evaluation also requires one or more non-economic predicates that GRE does not independently establish.*

Partial explanation should be distinguished from weak explanation. An economic component can be demonstrated with high confidence while the whole phenomenon remains multi-domain. A careful account of financing constraints on artistic production can be strong economic research even if it says little about aesthetic quality. Likewise, a robust estimate of the income effect of a health policy remains partial with respect to medical efficacy, legal permissibility, distributive justice, or lived experience. The scope label describes the breadth of the explanandum, not the reliability of the economic subclaim.

Several forms of partiality recur. *Constitutive partiality* occurs when another domain helps determine what the object is, as when legal status constitutes ownership or organizational form. *Mechanistic partiality* occurs when several mechanisms jointly produce an outcome. *Semantic partiality* occurs when economic manifestations do not exhaust the meaning of a practice or relation. *Normative partiality* occurs when GRE can describe consequences but cannot alone justify a judgment of legitimacy, justice, quality, or worth. *Historical partiality* occurs when present economic categories depend on historical formations that require reconstruction beyond contemporary measurement. *Observational partiality* occurs when the available manifestations identify only some relations relevant to the economic process.

Definition 23.472 (Explanatory-completion map). *An explanatory-completion map records which parts of a mixed-domain explanandum are currently warranted by GRE, which require neighboring-domain explanation, which interfaces connect the parts, and which residual questions remain unresolved even after the available domain accounts are combined.*

The map prevents an interdisciplinary project from assuming that several partial explanations automatically sum to a complete one. Domains can leave gaps between them. A legal classification can be known, an economic consequence estimated, and a political process reconstructed while the mechanism connecting them remains uncertain. Domain accounts can also conflict because they individuate the object differently or work at different temporal scales. Partial explanation therefore requires interface research rather than simple accumulation.

Proposition 23.473 (Partiality-preservation principle). *When a GRE explanation depends materially on constitutive, semantic, normative, mechanistic, or observational content that it does not itself warrant, the explanation should preserve that partiality explicitly rather than absorb the external content into an expanded economic vocabulary.*

lary.

This principle also guards against conceptual inflation. A theory becomes difficult to challenge when every important external relation is redescribed as economic simply because it affects economic outcomes. GRE's relational openness is better served by preserving the additional domain than by renaming it.

23.20.3 Domain Deference

Partial explanation identifies a shared explanandum. Domain deference identifies a different configuration: a GRE conclusion depends on a premise whose warrant lies principally elsewhere. The economic analysis can still be rigorous and consequential, but it should treat the imported premise as a typed dependency rather than silently re-establishing it through economic evidence. Section 23.16 developed this architecture for neighboring-domain contributions; the present subsection states its scope implication.

Legal validity is a clear example. GRE can ask what follows economically if a contract is enforceable, a person has a recognized legal status, or a property relation is valid. It can also study how anticipated legal recognition affects behavior before adjudication. Yet an econometric association between recognition and investment does not itself establish doctrinal validity. Political legitimacy supplies another example. GRE can investigate the distributional and generative consequences of a governance arrangement without concluding from efficiency, stability, or growth that the arrangement is legitimate. Similar distinctions apply to ecological integrity, educational quality, aesthetic judgment, social identity, technical capability, cybersecurity properties, and claims concerning consciousness or moral standing in AI-related inquiry.

Definition 23.474 (GRE deference point). A *GRE deference point* is a location in an economic argument where a materially relevant premise is constituted or warranted principally by a neighboring domain and is therefore imported conditionally, with its source authority and revision pathway preserved.

Definition 23.475 (External-warrant dependency). An *external-warrant dependency* records the source-domain premise on which a GRE claim depends, the economic inference that uses it, the strength and scope of the dependency, the source of authoritative correction, and the downstream GRE claims that require reconsideration if the premise changes.

Deference is not intellectual disengagement. GRE can test the economic sensitivity of alternative external premises. It can show that two plausible legal classifications produce very different patterns of access or dependence, that alternative ecological thresholds change investment feasibility, or that different educational judgments imply different interpretations of a capability policy. Such analysis can return useful questions to the source domain without claiming authority to settle the source-domain dispute.

Proposition 23.476 (Conditional-deference principle). *GRE can reason rigorously from a neighboring-domain premise without independently warranting that premise when the premise is typed as external, its economic consequences are stated conditionally, and revision of the premise propagates to the materially dependent economic conclusions.*

Difficult cases can contain several deference points with different authorities. A climate-transition policy may depend on ecological evidence, engineering feasibility, legal authority, political legitimacy, and economic financing conditions. The relevant domains can disagree or update on different schedules. GRE should therefore avoid replacing multiple external premises with a single synthetic variable whose provenance becomes invisible. A dependency graph can preserve where each warrant enters and which conclusions it affects.

Definition 23.477 (Multi-domain deference record). A *multi-domain deference record* is a provenance-preserving representation of multiple external premises entering one GRE inquiry, including their source domains, compatibility or conflict, update timing, affected economic claims, and unresolved interface questions.

23.20.4 Claims Beyond GRE Warrant

An open research programme also needs a current non-claim space. Some questions can be economically relevant yet remain outside the kinds of warrant developed in this book. Stating those exclusions is part of theoretical content because it makes over-reach identifiable and permits later evidence to justify principled expansion rather than retrospective reinterpretation.

The first excluded class concerns *ultimate ontology*. GRE uses relational, generative, historical, field-theoretic, dynamical, operator, geometric, and spacetime representations where they clarify economic questions. Their analytical success does not prove that reality is fundamentally relational, that economic reality literally has the mathematical structure of a chosen formal model, or that the preliminary GR vocabulary exhausts possible ontology. Ontological suspension remains the default.

A second class concerns *domain-specific status and normativity*. Economic evidence does not by itself establish legal validity, political legitimacy, moral standing, aesthetic quality, educational quality, ecological integrity, religious truth, medical efficacy, consciousness, or the full social meaning of an identity or practice. GRE can analyze the economic consequences of classifications in each domain and can sometimes expose material conditions that shape their realization. It cannot infer the underlying status merely from those consequences.

A third class concerns *unwarranted universality*. The fact that a relational or generative distinction is productive across several economic cases does not establish a universal social law, a transhistorical invariant, or a completed GRT. Section 23.19 made the generalization burden explicit. The present book provides a comparatively rich GRE domain, not the independent cross-domain evidence required for universal theory.

A fourth class concerns *causal strength beyond design*. GRE's interest in generation does not license strong causal attribution whenever a sequence is historically plausible or a formal model contains a transformation. Observational, historical, qualitative, experimental, quasi-experimental, and computational evidence each support different claims under different assumptions. A generative interpretation remains answerable to those evidential differences.

Definition 23.478 (GRE non-claim). A *GRE non-claim* is a proposition or predicate that the current framework treats as economically relevant or potentially interface-relevant but does not present as established by GRE because the required ontology, evidence, constitutive authority, normative warrant, or cross-domain generalization

exceeds the framework's present basis.

Proposition 23.479 (Non-claim discipline). *A question's importance to economic life does not by itself authorize GRE to answer it; where the required warrant lies outside GRE, the framework should state a conditional consequence, defer the constitutive judgment, or retain the question as an explicit non-claim.*

Non-claims are revisable. A future GRE programme may develop stronger evidence, new methods, or a more mature interface with another domain. The relevant claim can then move from non-claim to deference, from deference to partial explanation, or in some cases into direct scope. The present exclusion is therefore epistemic and disciplinary rather than an assertion that the question could never be studied economically.

Proposition 23.480 (No-authority-from-incidence). *Economic incidence, economic measurability, or economic policy relevance does not by itself confer authority to determine the non-economic status from which the measured consequence arises.*

23.20.5 Domain Counterevidence

Scope conditions become meaningful only when evidence can move a claim among them. Counterevidence can arise inside economics, but Chapter 23 has shown why neighboring domains also matter. A legal reconstruction can show that an assumed property relation did not exist in the relevant form. Historical evidence can show that a present category was unavailable to the actors being modeled. Ecological evidence can show that an economically represented resource flow omitted a binding biophysical constraint. Social research can show that an assumed independent choice was constituted through a relation the economic model treated as background. Technical evidence can show that an AI capability presumed in an economic scenario was not actually available. Each can change the economic explanation without requiring the external domain to become economics.

Definition 23.481 (Domain counterevidence to GRE). *Domain counterevidence to GRE* is evidence or warranted reconstruction from a relevant neighboring domain that materially undermines an economic classification, premise, mechanism, boundary, interpretation, generalization, or normative dependency used in a GRE claim.

Counterevidence should be typed by what it challenges. *Classification counterevidence* shows that an object or relation was misidentified. *Constitutive counterevidence* shows that the economic object depends on a different rule or relation than assumed. *Mechanism counterevidence* challenges the pathway linking economic conditions to outcomes. *Historical counterevidence* changes the relevant sequence, category, or path dependence. *Translation counterevidence* shows that a cross-domain mapping failed to preserve the structure required by the economic inference. *Formal counterevidence* shows that a mathematical assumption does not hold for the represented process. *Normative counterevidence* matters when GRE has explicitly relied on an external normative premise and the source domain revises that premise.

Definition 23.482 (GRE counterevidence record). *A GRE counterevidence record* identifies the challenged claim, source and type of counterevidence, affected assumptions, dependent conclusions, plausible alternative explanations, current response, and whether the appropriate revision is local correction, scope narrowing, retyping, decomposition, or abandonment.

The record prevents two symmetrical errors. One is defensive insulation, in which external counterevidence is dismissed because it did not originate inside economics. The other is indiscriminate collapse, in which criticism of one imported premise is treated as refutation of GRE as a whole. The claim-centered architecture permits targeted revision.

Proposition 23.483 (Targeted revision principle). *Domain counterevidence should revise the GRE claims that materially depend on the challenged premise or mapping, while broader framework revision is warranted only when the failure propagates to more central distinctions or recurs across sufficiently independent cases.*

This principle is compatible with strong criticism. If repeated counterevidence shows that a central GRE distinction cannot be operationalized, that value-conversion analysis consistently adds no explanatory discrimination, or that relational typing repeatedly obscures rather than clarifies causal structure, the required revision can become framework-level. Chapter 24 will make those stronger failure conditions explicit. The present section establishes the interface route by which such evidence can enter.

23.20.6 Scope-Boundary Revision

A revisable boundary can change in several directions. GRE can *expand* when recurrent research shows that a previously deferred predicate has developed a defensible economic formulation with distinct evidence and mechanisms. It can *contract* when purportedly economic claims prove dependent on external warrants that the framework cannot reconstruct. It can *retype* an object when the relevant economic predicate was misidentified. It can *decompose* a broad claim into a direct economic component and one or more external components. It can create a more explicit *interface* when neither absorption nor separation represents the problem adequately. In some cases it should *abandon* a claim that lacks evidential or conceptual support.

Definition 23.484 (GRE scope-boundary revision). *A GRE scope-boundary revision is a documented change in the framework's assignment of explanatory responsibility caused by new evidence, repeated interface dependence, failed translation, conceptual retyping, methodological development, historical change, or domain counterevidence.*

Boundary revision should not be opportunistic. A theory that expands whenever a neighboring domain produces a useful result and contracts whenever counterevidence appears would be difficult to test. Expansion and contraction therefore require explicit reasons, affected claims, and retained records of previous scope.

Definition 23.485 (GRE scope ledger). *A GRE scope ledger is a versioned record of direct-scope claims, partial-scope claims, deference points, non-claims, boundary disputes, counterevidence, rejected classifications, and subsequent expansions, contractions, retyplings, decompositions, or abandoned claims.*

The ledger can serve both theoretical and practical purposes. Theoretically, it permits future researchers to see whether GRE's domain has changed because evidence improved or because terminology became more elastic. Practically, it helps interdisciplinary teams identify which conclusions can be revised locally when one domain updates. It also preserves the history of failed formulations, which Section 23.19 treated as valuable evidence for future generalization.

Proposition 23.486 (Symmetric boundary burden). *Expansion and contraction of GRE's domain should both be justified by explicit evidence and conceptual reasons; neither disciplinary ambition nor disciplinary modesty is sufficient by itself to determine the boundary.*

Proposition 23.487 (Boundary-revision locality). *A justified revision should be as local as the evidence permits: retype or revise the affected claim first, enlarge the boundary revision only when the failure or new capability is shown to propagate across a wider part of the framework.*

The locality principle helps preserve cumulative knowledge. GRE need not choose between doctrinal rigidity and repeated reinvention. It can retain distinctions that continue to work while changing those that fail. This form of theoretical memory is especially important for a research programme intended to develop across long historical horizons and changing institutional conditions.

23.20.7 Interface Research Questions

The scope architecture leaves several open questions that cannot be settled by definition. One concerns the *threshold of economic typing*. Economic incidence is too broad, yet a narrow focus on prices, markets, or money would exclude many relations central to the book. Future research needs more discriminating criteria for when access, capability, recognition, dependency, or institutional constraint becomes an economic explanatory target rather than merely a background condition with economic effects.

A second question concerns *composition of partial explanations*. Even when several disciplines offer well-warranted accounts, there is no guarantee that their explananda, temporal scales, causal units, or normative objects align. Research is needed on how partial accounts can be composed without forcing equivalence, and how unresolved gaps should be represented when no common decomposition is available.

A third question concerns *conflicting correction authorities*. Law, ecology, political theory, education, social theory, technical disciplines, and affected communities can return corrections that are each authoritative within different predicates yet jointly difficult to satisfy. GRE requires procedures for recording such conflicts without collapsing them into one metric or allowing economic optimization to decide which external authority prevails.

A fourth question concerns *endogenous boundary change*. New institutions and technologies can alter the disciplinary object itself. AI-mediated contracting, programmable assets, ecological accounting, platform governance, new forms of collective organization, and changing legal personhood can create economic relations whose boundaries were not available to earlier theory. Scope conditions therefore need historical updating rather than being treated as a timeless taxonomy.

A fifth question concerns *empirical diagnostics of interface failure*. Chapter 23 has developed conceptual distinctions among translation loss, domain remainder, deference, overreach, and counterevidence. Future work needs empirical designs capable of identifying when a failed prediction or policy outcome arose from an economic mechanism, an imported premise, a cross-domain translation, or an omitted domain altogether.

A sixth question concerns the relation between *domain scope and future GRT*. Sec-

tion 23.19 argued that cross-domain generality becomes more credible when domain theories retain enough independence to reject inherited concepts. GRE therefore faces a productive tension: its own scope must be explicit enough to make comparison possible while remaining revisable enough that future cross-domain evidence can transform the concepts being compared.

Definition 23.488 (GRE interface research agenda). A *GRE interface research agenda* is a versioned set of unresolved questions concerning economic typing, partial-explanation composition, conflicting domain authority, historical boundary change, interface diagnostics, and cross-domain comparison whose answers can alter GRE's scope rather than merely add applications within a fixed framework.

The agenda distinguishes open problems from empty placeholders. Each question should eventually be connected to cases, evidence, methods, and possible outcomes that can revise the framework. An open research programme remains open because its concepts and boundaries are answerable to future inquiry, not because every result can be accommodated without consequence.

23.20.8 Limits Agenda for Chapter 24

Chapter 23 has treated primarily *interface limits*: boundaries of jurisdiction, translation failures, non-equivalent semantics, external-warrant dependencies, domain counterevidence, and restraints on generalization. These mark where GRE's authority ends because another domain has distinct objects, evidence, methods, or normative authority. They do not exhaust limitations internal to economic claims.

Chapter 24 takes that complementary object. It examines ontological restraint, epistemic and representational limits, relational and historical reconstruction, formalization, closure, heterogeneous value, power, justice, applied praxis, empirical identification, and normative underdetermination. It also asks which persistent failures would count against GRE or require major revision. The transition is from explicit scope to internal fallibility.

Definition 23.489 (Scope-limit handoff). The *scope-limit handoff* is the transition from identifying where GRE bears, shares, defers, or declines explanatory responsibility to examining limitations within the claims GRE undertakes.

A domain boundary is not itself a weakness: economics need not determine legal validity or aesthetic quality. Conversely, a direct-scope claim can still fail through poor evidence, misspecified relations, historical error, formal overreach, unobserved mechanisms, normative underdetermination, or superior rival explanations.

Proposition 23.490 (Scope-before-limit principle). *Evaluation of GRE's limitations should distinguish claims it undertakes from claims it addresses partially, imports conditionally, or declines; failure inside GRE's own responsibilities can then be separated from justified disciplinary restraint.*

Proposition 23.491 (Chapter 23 closure principle). *GRE remains an open research programme only if its interfaces both extend and constrain inquiry: neighboring domains can return corrections, and GRE can state where its explanations are direct, partial, deferred, unsupported, or boundary-revising.*

Chapter 23 therefore closes with bounded openness: GRE retains a recognizable economic problem-space while remaining corrigible through neighboring domains. Chapter 24 turns to limitations within the claims GRE itself undertakes.

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Chapter 24

Limits, Open Problems, and the Future of GRE

Internal Fallibility and Open Problems

Chapter 24 examines the limits that arise *within* the claims undertaken by Generative Relational Economics (GRE). Chapter 23 established a disciplinary scope architecture: some predicates fall directly within GRE, some require partial explanation, some depend on neighboring domains, and some should remain current non-claims. That distinction prevents a disciplinary boundary from being misdescribed as a theoretical failure. The present chapter takes the complementary problem. Even where GRE has legitimate explanatory responsibility, its ontological commitments can be too strong, its observations incomplete, its reconstructions underdetermined, its formalizations misspecified, its historical claims too broad, its value classifications unstable, its interventions practically unsafe, or its empirical identifications unsuccessful. A research programme becomes answerable only when these possibilities are stated as part of the theory rather than treated as external qualifications added after substantive claims have been made.

The chapter therefore uses *limit* in a disciplined sense. A scope boundary identifies a claim that GRE does not presently undertake. An uncertainty concerns incomplete confidence within an undertaken claim. An open problem identifies a question whose resolution remains outstanding. A limitation identifies a condition that restricts the warrant, applicability, resolution, interpretation, or practical reliability of a GRE claim. A failure condition identifies evidence or inconsistency that would count against a claim rather than merely leave it incomplete. These categories can overlap in a concrete research project, but they perform different theoretical functions. Keeping them distinct makes it possible to ask whether a problem calls for better evidence, narrower scope, a different model, another domain's expertise, conceptual revision, or abandonment of the claim.

This chapter has four principal objectives. First, it develops a limitation architecture for GRE across ontology, epistemology, manifestation and representation, relational reconstruction, history, formalization, closure, value, power, justice, application, domain transfer, and AI-mediated inquiry. Second, it turns several

substantive GRE concepts into explicit open research problems, including heterogeneous value, value conversion, value circulation, generativity, power conversion, and long-horizon relational effects. Third, it specifies failure modes, counterevidence, and conditions under which GRE would require local or framework-level revision. Fourth, it converts those limitations into a research programme that can guide empirical design, interdisciplinary collaboration, replication, conceptual repair, and later theoretical development.

The method is reflexive but not self-protective. A limitation should not be stated so vaguely that every result can be assimilated after reinterpretation. Where possible, the chapter asks what observation, comparison, failed reconstruction, rival explanation, normative disagreement, or practical outcome would expose the limitation. Conversely, a limitation should not be inflated into global skepticism. A model can be useful under restricted conditions; a historical reconstruction can remain informative despite missing archives; a formal representation can clarify structure without establishing ontology; and an intervention can be justified under uncertainty when monitoring, reversibility, participation, and revision pathways are proportionate to the stakes.

Several distinctions developed earlier in the book remain controlling. Ontological reality is normally suspended rather than asserted; relational reality and manifestational reality should not be collapsed; observations and transformations remain differently typed; generation, conversion, circulation, return, capture, dissipation, and regeneration are analytically distinct; generativity is not equivalent to goodness; stability is not equivalent to justice; formal elegance is not empirical warrant; and cross-domain translation does not establish theoretical identity. Chapter 24 treats failures to preserve such distinctions as possible sources of internal error rather than stylistic imperfections.

The internal sequence proceeds from general limitation discipline to increasingly specific problems. Sections 546–553 examine theoretical, ontological, epistemic, representational, relational, historical, formal, and closure limits. Sections 554–559 examine value, incommensurability, conversion, circulation, power, and justice. Sections 560–564 address applied praxis, domain transfer, AI-era inquiry, empirical identification, and normative underdetermination. Sections 565–567 then ask how GRE can fail, what evidence would count against it, and what would require major revision. Section 568 converts the resulting limitation record into an explicit open research programme. The immediate task is to clarify why limitations belong inside theory construction itself and how doing so can strengthen rather than weaken the claims GRE makes.

24.1 Theoretical Status of Limits

Chapter 23 distinguished legitimate disciplinary restraint from failure inside GRE's own explanatory responsibilities. The present section establishes the corresponding internal discipline for Chapter 24. Its role is to explain why limitations are part of theoretical content rather than an appendix of cautions, to distinguish limitations from uncertainty, scope boundaries, open questions, and counterevidence, and to show how explicit limits support revisability, domain specificity, research design, practical responsibility, and future theory development. The objective is not to weaken GRE

Table 24.1: Distinct roles of scope, uncertainty, limitation, open problems, and failure conditions in GRE

Category	Principal question	Research and theoretical response
Scope boundary	Is GRE responsible for this predicate?	Defer, share, or decline the claim; no internal failure is implied.
Uncertainty	How confident is the current inference?	Gather evidence, compare alternatives, or widen uncertainty representation; confidence can change without conceptual revision.
Limitation	Under what conditions is the claim reliable or interpretable?	State assumptions and restrict or redesign use; the claim remains but becomes conditionally specified.
Open problem	What unresolved question could materially change the framework?	Construct discriminating research designs; later inquiry can extend, narrow, decompose, or revise the claim.
Failure condition	What finding would count against the claim?	Test, replicate, compare rival explanations, and revise if triggered; local or broader theoretical revision can become required.

by surrounding every claim with qualifications. It is to make the strength of each claim legible: what the claim says, under which conditions it is warranted, what it leaves unresolved, how it could fail, and what kind of revision would follow. The method is claim-centered and versioned. Limits are attached to particular concepts, models, reconstructions, measurements, or interventions, and changes in those limits are treated as part of the history of the research programme.

The section begins from a distinction among five categories that can otherwise be conflated. A *scope boundary* concerns a claim outside GRE's present explanatory responsibility. An *uncertainty* concerns incomplete confidence in an undertaken claim. An *open problem* identifies a question that remains unresolved but researchable. A *limitation* restricts the conditions under which an undertaken claim can be interpreted, identified, generalized, or used. A *failure condition* identifies evidence or inconsistency that would count against the claim itself. These categories can interact, but they should not substitute for one another.

Definition 24.1 (GRE limitation). A *GRE limitation* is an explicit condition under which the warrant, identification, interpretation, applicability, comparative portability, or practical reliability of a GRE claim is restricted while the claim remains within GRE's stated explanatory scope.

Definition 24.2 (GRE open problem). A *GRE open problem* is a question whose resolution can materially alter the formulation, evidence, scope, comparison class, practical use, or revision status of a GRE claim and for which the research programme does not presently provide a settled answer.

Definition 24.3 (GRE failure condition). A *GRE failure condition* is a specified empirical, conceptual, formal, historical, or normative finding that would count against an undertaken GRE claim rather than merely indicate incomplete information about it.

Table 24.1 summarizes the distinction used throughout the chapter.

This taxonomy prevents two opposite errors. One is *protective relabeling*: counterevidence is redescribed as uncertainty or an open problem so that no claim can fail.

The other is *failure inflation*: any uncertainty, missing observation, or disciplinary boundary is treated as evidence that the theory is false. An answerable research programme needs enough structure to avoid both.

24.1.1 Theoretical Content of Limits

A theory is usually presented through the objects it distinguishes, the relations it proposes, the mechanisms it describes, and the consequences it expects. Yet every such claim also carries conditions under which its terms can be identified and its inferences remain warranted. If these conditions are omitted, the theory can appear more general than the evidence allows. Limitations are therefore not merely external judgments about an otherwise complete theory. They partly specify the content of the theory by identifying where a distinction stops discriminating, where a reconstruction becomes underdetermined, where a model assumption ceases to hold, or where an intervention loses practical reliability.

Consider generativity. GRE can ask whether a resource, relation, institution, or intervention contributes to later capacities, relations, option-spaces, or value-generating processes. The analytical content of such a claim depends on a temporal horizon, a relevant population or relational configuration, an account of what is being generated, and an evidential route linking earlier conditions to later changes. If the horizon is unspecified, if the generated object cannot be distinguished from ordinary persistence, or if several rival mechanisms produce the same manifestation, the limitation is internal to the claim. It identifies what must be resolved before the claim can carry stronger explanatory weight.

The same logic applies to relational explanations. Saying that an outcome is relationally generated does not establish which relations are constitutive, which are background conditions, how the relevant boundary is drawn, or whether an alternative non-relational description explains the evidence more parsimoniously. A limitation statement can therefore sharpen the explanandum by requiring the research design to identify the relevant relational level and specify what evidence would distinguish competing reconstructions.

Proposition 24.4 (Limit-content principle). *For an answerable GRE claim, conditions that materially restrict identification, interpretation, scope, or practical use belong to the claim's theoretical specification rather than to an optional catalogue of external caveats.*

This principle does not require maximal qualification. A theory would become unusable if every logically possible exception were enumerated. The relevant limits are those that can change the meaning, evidential burden, comparative interpretation, or actionability of the claim. Their inclusion should increase discriminating content rather than merely lengthen the text.

24.1.2 Revision Conditions

Explicit limits make revision more precise. Without them, a failed prediction or problematic case can produce an unstructured choice between defending the entire framework and abandoning it. A limitation architecture permits more local responses. A measurement problem can be repaired without changing ontology. A failed formal closure can require a different model while preserving the substantive distinction

under study. A historical counterexample can narrow a generalization without invalidating the mechanism in the settings where it remains supported. A normative disagreement can expose underdetermination without refuting a descriptive finding.

Definition 24.5 (GRE revision trigger). A *GRE revision trigger* is an observation, counterexample, failed identification, internal inconsistency, rival explanation, practical outcome, or domain correction that activates a previously stated limitation or failure condition strongly enough to require reconsideration of an affected claim.

Definition 24.6 (GRE revision pathway). A *GRE revision pathway* is the documented sequence through which a triggered limitation produces a local repair, scope restriction, semantic retyping, model replacement, decomposition, evidential downgrade, or broader framework revision.

Revision should preserve theoretical memory. If a formulation is narrowed after a counterexample, the earlier formulation and reason for revision remain analytically useful. They show which assumption failed and prevent future researchers from unknowingly reconstructing the same overclaim. A versioned limitation record therefore complements the scope and generalization ledgers developed in Chapter 23.

Proposition 24.7 (Local-revision presumption). *When counterevidence targets a separable claim, GRE should revise that claim locally before inferring failure of more general commitments; broader revision becomes warranted when the failure is shown to propagate through shared definitions, assumptions, or inferential dependencies.*

The presumption is methodological, not protective. Some failures do propagate. An inconsistency in a core distinction can affect many later claims. A recurrent inability to identify generativity could weaken a substantial part of the programme. The point is to trace the dependency rather than infer the scale of revision from the emotional or rhetorical importance of the challenged claim.

24.1.3 Domain-Specific Limitation Profiles

GRE is domain-specific even when it uses concepts with broader relational analogues. Its limitations should therefore also be typed by domain. Economic value conversion can face identification problems that do not arise in the same form in aesthetics or law. Economic participation can be measured through access, bargaining, institutional voice, or capability while political participation carries different constitutive and normative conditions. An empirical limitation in one domain should not automatically be promoted into a general limitation of every GR-oriented theory.

A useful limitation record consequently needs both a claim and a domain index. It should state whether the problem arises from economic institutions, the historical setting, a particular measurement technology, a formal representation, the available data, or a more general conceptual assumption. The distinction matters for future GRT work because a limitation that disappears after domain reconstruction is evidence against premature generalization, whereas a limitation that independently reappears across heterogeneous domains may itself identify a candidate general research problem.

Definition 24.8 (Domain-specific limitation profile). A *domain-specific limitation profile* records a claim's limiting conditions together with the domain objects, institutions, evidential access, historical setting, methods, and external warrants that generate or mediate those limitations.

Proposition 24.9 (Limit non-transfer principle). *A limitation identified in GRE should not be assigned automatically to another GR domain or to a future GRT; its portability requires independent reconstruction of the mechanism or condition that generated the limitation.*

This also applies in the opposite direction. A legal or ecological limitation can constrain an economic claim when the claim depends on a legal or ecological premise, but the route of dependence should be explicit. Chapter 23 described such relations through external-warrant dependencies. Chapter 24 adds the requirement that limitations on those premises propagate only through the claims that actually depend on them.

24.1.4 Epistemic Restraint

Epistemic humility in GRE should be operational rather than ceremonial. Statements such as “the evidence is limited” contribute little unless the relevant limitation changes the claim, confidence, design, or decision. The stronger discipline is to identify what is unobserved, what reconstruction is non-unique, which alternative explanation remains plausible, which historical records are missing, or which parameter cannot presently be identified.

This is particularly important because much GRE inquiry has an inverse structure. Researchers observe manifestations and attempt to reconstruct latent relations, histories, constraints, or generative processes. Several underlying structures can sometimes produce similar manifestations. A limitation statement must therefore distinguish unavailable evidence from genuine non-identifiability. More data can reduce the former; the latter can persist even with extensive observation if the mapping from relational structures to manifestations is many-to-one.

Definition 24.10 (Calibrated epistemic restraint). *Calibrated epistemic restraint* is the practice of matching the strength, resolution, and generality of a GRE claim to the available observational access, identification conditions, rival explanations, historical evidence, and model dependence relevant to that claim.

Calibrated restraint permits strong conclusions where evidence is strong. It does not require every statement to remain tentative. A narrowly specified institutional mechanism can be well supported even when a wider historical or ontological interpretation remains unsettled. Conversely, mathematical precision cannot compensate for weak identification. Confidence should track the warrant attached to the claim rather than the sophistication of its representation.

Proposition 24.11 (Precision–warrant distinction). *Greater formal or numerical precision does not by itself increase the epistemic warrant of a GRE claim when observational access, identification, historical evidence, or model adequacy remain weak.*

24.1.5 Research-Design Consequences

A limitation becomes theoretically productive when it changes research design. If relation identification is uncertain, the design can collect multiple forms of relational evidence rather than only actor attributes. If historical categories change over time, the design can avoid treating a present classification as temporally invariant. If value forms are heterogeneous, measurement can preserve several value types instead of forcing early aggregation. If an intervention can alter the observational process, the

research design can distinguish pre-intervention evidence from manifestations produced by the intervention itself.

The relevant movement is therefore from limitation to diagnostic question and from diagnostic question to method. A formal limitation can motivate sensitivity analysis or an alternative model class. An epistemic limitation can motivate triangulation or comparative reconstruction. A normative limitation can motivate explicit plural evaluation rather than silent substitution of one metric. A practical limitation can motivate staged implementation, monitoring, or reversible experimentation.

Definition 24.12 (Limitation-to-design mapping). *A limitation-to-design mapping connects a stated theoretical limitation to one or more research procedures capable of diagnosing, bounding, comparing, or reducing its effect without presuming that the limitation can always be eliminated.*

Proposition 24.13 (Research-design relevance). *A limitation statement has stronger research value when it implies observable diagnostics, comparison strategies, sensitivity analyses, alternative representations, or data requirements through which the affected claim can be challenged or refined.*

Some limitations will remain irreducible. Historical archives can be permanently lost; counterfactual trajectories can remain underdetermined; value conflict can persist after extensive deliberation. Research design should then represent the residual limitation rather than conceal it behind a single estimate or summary category.

24.1.6 Practical Responsibility under Limitation

Application changes the significance of uncertainty and limitation because theoretical error can alter institutions, resource flows, participation, capabilities, or future option-spaces. A limitation that is tolerable in exploratory modeling can become unacceptable when an intervention is difficult to reverse or when those bearing the downside have little influence over the decision. Practical responsibility therefore depends not only on estimated benefits but also on the structure of possible error.

GRE should distinguish at least four practical questions. First, who is exposed if the relational model is wrong? Second, which effects can be reversed or compensated? Third, who can detect and report emerging failure? Fourth, which institutional pathway permits the intervention to be modified or stopped? These questions connect epistemic limits to participation and power rather than treating uncertainty as merely statistical.

Definition 24.14 (Practical limitation burden). *A practical limitation burden is the additional evidential, participatory, monitoring, reversibility, or safeguarding requirement created when a GRE-guided intervention can impose material consequences despite unresolved limitations in the underlying claim.*

Proposition 24.15 (Stakes-sensitive responsibility). *The practical burden associated with a GRE limitation should increase with the magnitude, irreversibility, distributional concentration, opacity, and participation asymmetry of the consequences that can follow if the affected claim is wrong.*

This principle does not imply paralysis under uncertainty. Many economic decisions cannot wait for complete knowledge. It instead favors proportional safeguards and explicit revision pathways. An intervention can proceed under uncertainty when the reasons are stated, affected parties have appropriate standing, monitoring can re-

veal relevant failures, and institutions retain capacity to respond.

24.1.7 Constraints on Future Theory

Limitations also constrain how GRE should develop theoretically. New concepts should not be added only because an existing distinction encounters difficulty. Conceptual expansion can solve a local problem while reducing testability if every anomaly generates another flexible category. Future theory development therefore needs to record whether a new construction narrows ambiguity, creates new observable distinctions, improves comparison, or merely redescribes a failure.

The same discipline applies to formalism. A richer mathematical representation can expose structure that prose leaves ambiguous, but it can also hide unsettled semantics behind notation. Later formal development should identify which limitation it addresses and what new consequences become assessable. A formal extension earns theoretical status when it clarifies a relation, generates discriminating implications, or reveals inconsistency; elegance alone is insufficient.

Definition 24.16 (Limitation-guided theory development). *Limitation-guided theory development* is the extension, decomposition, or reformulation of GRE in response to a documented limitation whose proposed repair yields clearer semantics, stronger identification, better comparative discrimination, or more explicit failure conditions.

Limitations can therefore function as selection pressure on the research programme. Some will motivate narrower claims. Others will motivate new empirical methods or cross-domain collaboration. A smaller set may justify new concepts or formal structures. Still others may reveal that a favored distinction should be abandoned. The future of GRE is strengthened when these possibilities remain institutionally and conceptually available.

Proposition 24.17 (Repair-burden principle). *A proposed theoretical repair should identify the limitation it addresses and should add discriminating content or revision capacity sufficient to justify the additional conceptual or formal complexity it introduces.*

24.1.8 Research under Fallibility

Treating limitations as theoretical content can be mistaken for skepticism if fallibility is understood as the absence of warranted claims. GRE requires the opposite position. Research can make locally strong claims while remaining explicit about the conditions that would narrow or overturn them. Fallibility concerns revisability in principle and answerability to evidence, not the refusal to distinguish better-supported explanations from weaker ones.

This orientation is especially compatible with the relational commitments of the book. Relations, institutions, meanings, and manifestations can change historically; observation can alter the system being studied; categories can become performative; and interventions can transform the conditions under which earlier findings were obtained. A claim that was well warranted in one period can therefore become less applicable without having been irrational when first made. Versioned limitations allow the theory to represent this temporal dimension of knowledge.

Definition 24.18 (Constructive fallibility). *Constructive fallibility* is a research orientation in which GRE permits strong, contestable claims while preserving explicit lim-

itation profiles, failure conditions, revision triggers, and historical records through which those claims can be narrowed, repaired, or rejected.

Definition 24.19 (GRE limitation register). A *GRE limitation register* is a versioned record linking substantive claims to their scope status, uncertainty sources, limiting conditions, open problems, failure conditions, revision triggers, research-design responses, practical burdens, and subsequent theoretical changes.

The register makes limitation cumulative rather than repetitive. Later work need not rediscover that a formalism depended on closure, that a historical result relied on incomplete archives, or that a value conversion was only locally commensurable. It can test whether the limitation remains, has been reduced, has changed form, or has propagated into another part of the framework.

Proposition 24.20 (Limit-answerability principle). A *GRE claim* is more theoretically answerable when its limiting conditions and possible failure states are explicit enough that later inquiry can distinguish confirmation, unresolved uncertainty, boundary restriction, local revision, and genuine counterevidence.

The resulting stance is neither maximalist nor skeptical. GRE should state what it currently has reason to claim, the conditions supporting that claim, and the routes by which future evidence can change it. The present section therefore supplies the organizing discipline for the rest of Chapter 24. The next section applies it first to ontology, where the distinction between useful relational representation and stronger claims about what ultimately exists requires particularly careful restraint.

24.2 Ontological Limits

Chapter 4 introduced the ontological architecture used throughout this book: ontological reality is normally left under suspension; relational reality identifies historically generated configurations that persist with sufficient stability and causal efficacy to participate in subsequent relations; manifestational reality concerns the context-dependent forms through which realities become present to subjects, instruments, institutions, classifications, and other configurations. The present section returns to that architecture from a different direction. Its role is to identify the conditions under which those distinctions cease to warrant stronger conclusions, the assumptions they leave open, and the kinds of evidence that would require ontological revision. The objective is therefore diagnostic rather than metaphysically constructive. The section examines ontological suspension, relational and manifestational reality, stronger ontological commitments, domain-specific ontologies, possible non-relational objects or properties, multiple realization, and the limits of relational primacy. Its method is internal criticism: the analysis asks what GRE currently commits itself to, what it deliberately leaves unsettled, and how its ontological vocabulary could become too strong, too weak, or insufficiently discriminating.

The starting point is a distinction between *ontological usefulness* and *ontological closure*. GRE needs objects, relations, events, constraints, processes, subjects, institutions, values, and histories that are real enough to enter explanation. An inquiry that refuses every ontological commitment cannot identify anything whose persistence or transformation matters. Yet explanatory usefulness does not establish that the selected categories are exhaustive, fundamental, uniquely individuated, or invariant across domains and scales. The ontological limitation problem begins precisely

Table 24.2: Ontological claim levels and corresponding GRE restraint

Claim level	Legitimate analytical use	Principal ontological limitation
Operational object	Treat a configuration as stable enough for a stated inquiry.	Task-relative usefulness does not establish unique or fundamental identity.
Relational reality	Attribute persistence and causal efficacy within a specified generative-relational system.	Stability and efficacy do not establish exhaustive constitution or ultimate ontology.
Three registers	Separate ontological, relational, and manifestational questions.	The three-register architecture may require refinement, extension, or domain-specific reconstruction.
Stronger ontology	Assert a more specific account of what an object ultimately is or what kinds of reality are fundamental.	GRE requires additional warrant when the stronger commitment exceeds the explanatory needs of the economic inquiry.

where a working analytical object is promoted into a stronger claim than the research question or evidence requires.

Definition 24.21 (Ontological limitation in GRE). An *ontological limitation in GRE* is a condition under which an object, relation, process, register, identity criterion, or ontological distinction remains analytically useful while the available warrant is insufficient to establish its fundamentality, exhaustiveness, uniqueness, cross-domain invariance, or independence from the boundary and scale of inquiry.

Definition 24.21 makes ontological limitation compatible with substantive explanation. A market can be treated as a relationally real institution without establishing that markets form an ultimate ontological kind. A person, organization, currency, legal category, artificial system, or ecological resource can be an economically consequential object without GRE resolving every metaphysical question about its constitution. The limitation lies in the distance between the strength needed for the analysis and the stronger claim that could be inferred from it.

Table 24.2 summarizes four recurrent ontological claim levels and the corresponding restraint required in this chapter.

The table is not a hierarchy in which stronger claims are always preferable. A research programme gains rigor when its ontological strength matches its evidential and explanatory burden. Excess strength creates overreach; insufficient strength can leave the objects of inquiry too indeterminate to support explanation. The relevant task is calibration.

24.2.1 Ontological Suspension

Ontological suspension is the principal device through which GRE separates local explanatory commitment from claims about ultimate constitution. It does not mean that the programme treats all ontological possibilities as equally plausible, or that it refuses to say what kinds of objects participate in economic explanation. Rather, it withholds stronger closure where several materially different ontological interpretations remain compatible with the evidence and where choosing among them would add little to the present explanatory task.

This restraint has a positive analytical function. Suppose an institutional identity persists through changes in personnel, documentation, ownership, and internal procedure. GRE can investigate the relations that reproduce that identity, its effects on resource allocation, and its role in later value generation without first determining whether the institution should ultimately be understood as a legal fiction, a social object, a pattern of practices, an information-bearing organization, or another ontological kind. Suspension permits the inquiry to proceed on the structure shared by the interpretations that remain live.

Suspension nevertheless has limits of its own. If rival ontological interpretations generate materially different predictions, intervention consequences, identity criteria, or normative implications, continued suspension can obscure a disagreement that has become operative. A claim that an artificial system is merely an instrument and a claim that it possesses a form of subjecthood, for example, may be interchangeable for some productivity analyses while becoming highly consequential for responsibility, standing, or participation. GRE cannot resolve such questions solely because they become important, but it should identify the point at which its economic analysis begins to depend on an ontological premise supplied elsewhere.

Definition 24.22 (Ontological suspension boundary). An *ontological suspension boundary* is the point at which competing ontological interpretations cease to be interchangeable for a GRE claim because their differences alter the identification of objects, admissible mechanisms, expected consequences, intervention design, or evaluation of the economic process under study.

The boundary makes suspension conditional rather than indefinite. GRE can remain neutral where the disagreement is inert for its present purpose and should expose the dependency where the disagreement becomes consequential. This also prevents ontological suspension from functioning as a device for avoiding difficult evidence. If an explanation depends on treating an object as persistent across a transformation, the identity criterion supporting that persistence should be defended rather than placed under suspension after the fact.

Proposition 24.23 (Suspension calibration principle). *GRE should maintain ontological suspension when stronger alternatives are not discriminated by the relevant evidence or explanatory task, and should identify or import additional ontological warrant when those alternatives generate materially different consequences for an undertaken claim.*

The proposition preserves two kinds of humility. GRE should not promote analytical convenience into metaphysics. It should also not invoke suspension where its own claims already depend on a particular ontology. The limitation register introduced in Section 546 can therefore record whether an ontological issue is genuinely suspended, operationally fixed for a local task, or externally dependent on another domain's account.

24.2.2 Relational Reality

Relational reality is among the most consequential constructions in the book because it permits GRE to treat historically generated objects as real without requiring them to be fundamental substances. The criterion combines emergence within a generative-relational system, sufficient persistence over a relevant interval or region, and causal efficacy within later processes. Money, organizational identity, trust, debt, reputation,

institutional authority, and many other economically consequential objects can be studied through this criterion.

The criterion also contains several limitations that become more visible when it is used empirically. First, persistence is scale-relative. A configuration can be stable for the duration of a transaction and unstable across a generation. Second, causal efficacy is boundary-dependent. A pattern that appears inert inside a narrow system may matter strongly once downstream or cross-domain effects are included. Third, emergence can be multiply reconstructible. Several histories can be compatible with the same present configuration. Fourth, causal efficacy can be difficult to distinguish from repeated analyst classification when the relevant intervention, counterfactual, or temporal evidence is weak.

Definition 24.24 (Relational-reality warrant profile). A *relational-reality warrant profile* records the evidence supporting the emergence, persistence, causal efficacy, boundary, scale, and identity conditions under which an object is treated as relationally real in a particular GRE inquiry.

The profile does not create a universal metric of relational reality. Its purpose is to expose the dimensions on which the attribution depends. Evidence can be strong for persistence and weaker for generative origin; strong for causal efficacy at one scale and uncertain at another. Recording these asymmetries is more informative than assigning a single degree of reality.

A second limitation concerns exhaustiveness. Demonstrating that an object is relationally real does not establish that its relevant properties are fully generated by the relations included in the model. A worker's legal position, physiological capacities, material environment, memory, or technical skill can enter an economic relation with histories and properties that are not reducible to the relation being studied. Relational reality therefore gives GRE a criterion for causal participation, not a license to explain every property through one relational system.

Proposition 24.25 (Non-exhaustiveness of relational reality). *Establishing that an object is relationally real within a specified generative-relational system does not establish that the object's constitution, capacities, identity, or causal powers are exhausted by the relations represented in that system.*

This proposition is important for the economic domain because economically relevant objects routinely cross disciplinary boundaries. A property right is relationally real within economic practice while its legal validity depends on legal institutions. An ecological object can constrain production while possessing biological or physical dynamics that economic relations do not generate. An AI system can occupy an economically consequential position while its technical architecture remains a distinct explanatory object. GRE should therefore use relational reality to identify participation and effect while preserving the possibility of constitutive remainder.

A third limitation concerns stabilization. Persistence and causal efficacy can arise through domination, coercion, path dependence, classification, or repeated institutional reinforcement. Relational reality is consequently descriptive before it is evaluative. Stable reality does not imply desirability, legitimacy, justice, or normative priority. Chapter 24 will return to these distinctions when considering power and justice; at the ontological level, the relevant point is that reality-status should not silently acquire evaluative force.

24.2.3 Manifestational Reality

Manifestational reality concerns the forms through which realities become available within a particular configuration of subject, instrument, institution, archive, interface, classification, language, or model. Prices, reports, rankings, measurements, legal records, narratives, images, dashboards, and experienced appearances can all participate in manifestation. GRE treats these forms seriously because manifestations can become causally consequential: a classification can redirect eligibility, a published index can alter expectations, and an AI-generated representation can change subsequent decisions.

The ontological limitation is that manifestation does not uniquely settle what is manifested. Similar manifestations can arise from different relational structures, and different manifestations can arise from the same relationally persistent object. A sudden price increase can manifest scarcity, strategic withholding, policy change, speculative expectation, measurement revision, or combinations of these mechanisms. A stable institutional label can persist while its underlying relations change substantially. An apparent change can also be produced by an altered measurement or classificatory system while the relevant relational structure changes less than the manifestation suggests.

These possibilities will receive a dedicated epistemic and representational treatment later in the chapter. At the present ontological level, they establish that manifestation should not be treated as a transparent identity relation between appearance and reality. The same caution applies in the opposite direction. A manifestation can become part of the causal organization of the system, so it should not be dismissed as merely secondary or representational.

Definition 24.26 (Manifestational ontological remainder). *A manifestational ontological remainder is the portion of an object's constitution, history, causal structure, or possible realization that is not fixed by a particular manifestation even when that manifestation is informative and causally consequential.*

The remainder is not necessarily unknowable. Additional manifestations, interventions, historical evidence, technical inspection, or cross-domain inquiry can reduce it. The concept instead blocks the inference that one mode of access exhausts the object. It also allows GRE to compare manifestations without assuming that the comparison already supplies a common ontological measure.

Proposition 24.27 (Manifestation non-exhaustion). *A manifestation can provide evidence about, and can become causally involved in, a relationally real object while remaining insufficient to establish the object's complete ontological constitution or unique generative history.*

This proposition matters especially where economic governance relies on classifications and metrics. A credit score, productivity indicator, educational credential, risk category, or platform rating can have substantial economic reality because institutions act on it. Its efficacy does not establish that the category fully captures the person, organization, capability, or risk it represents. Ontological restraint therefore accompanies the practical seriousness of manifestation.

24.2.4 Stronger Ontological Commitments

GRE sometimes requires commitments stronger than generic ontological suspension. A research design may need to decide whether two observations concern the same object across time, whether a process continues through institutional change, whether a subject persists across changes in representation, or whether a material constraint exists independently of current recognition. These are ontologically substantive decisions because they determine what can enter causal and historical explanation.

The limitation question is not whether stronger commitment is prohibited. It is what burden should accompany the increase in ontological strength. Four considerations are especially relevant. The first is *explanatory necessity*: does the stronger commitment permit an inference that the weaker formulation cannot support? The second is *discriminating consequence*: would alternative ontological commitments produce observably or practically different implications? The third is *evidential accessibility*: what evidence could support or challenge the commitment? The fourth is *domain authority*: does GRE possess the relevant warrant, or does the claim depend on another discipline?

Definition 24.28 (Ontological escalation). *Ontological escalation* is the movement from a weaker analytical commitment to a stronger claim concerning the identity, constitution, persistence, fundamentality, or causal independence of an object or process.

Ontological escalation can be justified. A material intervention can show that a previously hypothetical constraint continues to operate across changes in representation. Legal analysis can establish that two organizational manifestations belong to the same juridical person for a specified purpose. Technical inspection can distinguish two computational systems that produce similar outputs while having materially different architectures. The relevant requirement is that the stronger claim earn its additional content.

Proposition 24.29 (Escalation burden). *A stronger ontological commitment in GRE should identify the additional explanatory work it performs, the evidence or external warrant that supports it, and the consequences that would differ if the commitment were weakened or rejected.*

This burden limits speculative accumulation. A framework does not become more rigorous simply by assigning more metaphysical detail to its objects. Additional commitments can reduce portability, create hidden dependencies, or generate false precision. Ontological strength is useful when it enables better discrimination, not when it merely thickens vocabulary.

The same principle applies to formal language. A 2-complex, field, state space, operator algebra, category, attractor, or other formal structure can represent selected aspects of economic or relational organization. Using the representation does not by itself escalate the ontological claim. Escalation occurs when the representation is asserted to reveal what the system ultimately is, or when alternative realizations are excluded without independent argument. Chapter 24 will examine these issues further under formalization limits.

24.2.5 Domain-Specific Ontologies

Chapter 23 established that neighboring domains can share objects while retaining distinct explanatory jurisdictions. Ontology follows the same discipline. An object can be economically real, legally constituted, politically authorized, socially recognized, ecologically constrained, technically implemented, and aesthetically experienced through partially overlapping but non-identical identity conditions. The fact that one empirical configuration participates in all of these domains does not imply that one domain's ontology should govern the others.

A corporation illustrates the issue. GRE can treat it as an economic subject or relational configuration when analyzing investment, employment, bargaining, production, or value circulation. Law can determine juridical personality, rights, liabilities, and continuity under transformations that economic analysis might classify differently. Political theory can ask about authority and accountability; social theory can examine organizational fields and identity; technical inquiry can treat computational infrastructure as a distinct component. These accounts can constrain one another while preserving different predicates and individuation rules.

Definition 24.30 (Domain-indexed ontological profile). *A domain-indexed ontological profile records how an empirical configuration is individuated, stabilized, and treated as causally or normatively consequential within a specified domain, together with the interfaces through which that profile depends on or conflicts with other domains.*

A domain-indexed profile helps prevent cross-domain vocabulary from producing hidden identity claims. Terms such as subject, institution, value, agency, property, person, resource, or environment can recur while carrying different constitutive criteria. The profiles can overlap substantially; some cases may eventually support stronger cross-domain structure. Their present similarity should nevertheless remain a hypothesis to be established rather than an assumption inherited from common language.

Proposition 24.31 (Domain-ontology non-collapse). *Shared reference to an empirical configuration across domains does not by itself establish shared identity conditions, causal ontology, normative status, or explanatory priority across those domains.*

This proposition places a limit on GRE expansion. Economic importance cannot settle legal personality, moral standing, political membership, ecological identity, or technical agency. Conversely, a neighboring domain can correct the object structure used by GRE when its account reveals that an economically convenient category combines entities whose constitutive differences materially affect economic explanation. Ontological pluralism can therefore be a source of correction rather than a sign that the domains lack common objects.

24.2.6 Non-Relational Objects

A relational research programme faces a distinctive risk: once relation becomes analytically productive, every relevant feature can be redescribed as relational and the possibility of non-relational explanatory content can disappear by definition. GRE should avoid this closure. The present framework gives relations methodological and explanatory priority in many economic questions, but it does not establish that every causally relevant property is relationally constituted or that every adequate explanation must reduce its objects to relations.

The category *non-relational object* requires care. It can refer to an object whose existence is claimed to be independent of relations, to an intrinsic property that remains explanatory across changes in relation, or simply to a feature for which the relational constitution has not been demonstrated. These possibilities are different. GRE need not assert a metaphysics of intrinsic substance in order to recognize that some material, biological, technical, or logical properties may enter an economic explanation as constraints or capacities that the selected economic relations do not generate.

For example, the thermal tolerance of a material can constrain an industrial process. A physiological capacity can limit labor or care arrangements. A cryptographic property can constrain the feasible operations of a technical system. Each property can participate in relations and acquire economic consequences while its relevant causal structure may be better explained through another domain. Calling the consequence relational does not require claiming that the underlying property was generated by the economic relation.

Definition 24.32 (Relational adequacy challenge). *A relational adequacy challenge arises when an empirically consequential feature is not adequately identified, predicted, or explained by the relations represented in a GRE analysis and when an intrinsic, material, domain-specific, or differently structured account provides additional discriminating content.*

The challenge is methodological rather than an automatic refutation of relational analysis. The relevant response can be to enlarge the relational boundary, import another domain's mechanism, represent the feature as an exogenous condition, or revise the claim that the relation was constitutively sufficient. Different cases will support different repairs.

Proposition 24.33 (Relational sufficiency test). *When a GRE explanation attributes an object's relevant capacity or outcome primarily to relational organization, the explanation should remain open to comparison with accounts in which some causally relevant properties are not generated by the represented relations.*

This proposition gives relational primacy an empirical vulnerability. If non-relational or differently constituted properties repeatedly explain outcomes that GRE attributes to relational structure, the appropriate response is not to redescribe those properties as relations by stipulation. The theory should narrow, decompose, or revise the attribution. A relational research programme remains informative only when relation excludes or differentiates alternatives rather than absorbing them terminologically.

24.2.7 Multiple Realization

Multiple realization creates a different ontological limit. Similar economic functions, relational positions, or manifestational outputs can be produced by heterogeneous underlying structures. A payment function can be realized through cash, bank deposits, mobile money, tokens, or institutional credit arrangements. Organizational memory can be realized through persons, documents, databases, routines, or combinations of these forms. Coordination can be realized through prices, rules, hierarchies, conventions, or technical protocols. Treating these realizations as equivalent for a specified purpose can be analytically useful while leaving their ontological and causal differences intact.

The converse problem also matters. Heterogeneous realizations need not imply dis-

tinct economic functions. If every material or institutional difference generates a new ontological category, the framework can lose the abstraction needed for comparison. GRE therefore needs identity criteria that state which differences are intentionally ignored for a given claim and which would alter the mechanism under study.

Definition 24.34 (Realization-sensitive equivalence). A *realization-sensitive equivalence* is a task-relative judgment that heterogeneous realizations can be treated as equivalent with respect to specified functions, relations, or consequences while preserving the realization differences that remain causally, historically, normatively, or practically relevant.

This definition provides a middle position between ontological collapse and excessive fragmentation. It allows a researcher to compare different monetary instruments as payment mechanisms while retaining differences in privacy, settlement risk, legal status, infrastructure dependence, or access. It allows AI-mediated and human-mediated tasks to be compared functionally while preserving differences in responsibility, embodiment, training history, or technical failure modes.

Proposition 24.35 (Multiple-realization restraint). *Functional or relational equivalence across heterogeneous realizations warrants only the equivalence dimensions established by the comparison; it does not establish ontological identity, identical causal mechanisms, or interchangeability under other tasks.*

Multiple realization also weakens simple inference from manifestation to constitution. Two systems can produce similar outputs through different mechanisms, and one system can preserve its relevant function through substantial changes in realization. This reinforces the need for scale- and task-relative identity criteria. It also creates an empirical programme: research can ask which realization differences matter for generativity, power, robustness, justice, conversion, circulation, or long-horizon capability formation rather than assuming the answer from surface equivalence.

24.2.8 Limits of Relational Primacy

The strongest ontological limitation concerns the status of relation itself. GRE is relational in more than a descriptive sense. It repeatedly treats positions, capacities, values, identities, constraints, institutions, and historical trajectories as partly constituted through relations and through the generative histories of those relations. This orientation is theoretically productive because it reveals mechanisms that actor-isolated or static descriptions can miss. Its success nevertheless does not establish one undifferentiated thesis of relational primacy.

Three forms of primacy should be separated. *Methodological relational priority* means that an inquiry begins by examining relations and histories rather than assuming that isolated entities carry a complete explanation. *Explanatory relational priority* means that, for a specified phenomenon, relational organization explains more of the relevant variation or mechanism than rival descriptions centered on isolated properties. *Ontological relational priority* is stronger: it claims that relation is constitutively or fundamentally prior to the objects that enter it. GRE can adopt the first as a broad research orientation and establish the second locally where evidence supports it. The third requires additional argument and is normally left under suspension.

Definition 24.36 (Relational primacy profile). A *relational primacy profile* specifies whether a GRE claim assigns methodological, explanatory, or ontological priority to relations, together with the domain, scale, evidence, and alternatives against which

that priority is asserted.

The profile prevents a common escalation. A study can show that network position predicts access better than an individual attribute without proving that the individual is ontologically constituted only by the network. Historical analysis can show that an institution emerged through relations without proving that every later property of the institution is reducible to the originating relations. A formalism can encode relational states without establishing that the world is fundamentally a relational state space.

The profile also creates explicit failure conditions. Explanatory relational priority should weaken when non-relational or differently structured rival models repeatedly identify mechanisms, predict outcomes, or support interventions more successfully for the same target. Methodological priority should be reconsidered when beginning from relational decomposition systematically obscures stable objects or properties that are needed for the inquiry. Ontological relational priority would require a much stronger evidential and philosophical burden than this book undertakes.

Proposition 24.37 (Bounded relational primacy). *GRE may give relations methodological priority and establish local explanatory relational priority while leaving universal ontological relational priority open to independent argument.*

Definition 24.38 (Ontological revision trigger). An *ontological revision trigger* is sustained evidence that GRE's current object distinctions, register architecture, identity criteria, relational attributions, or realization equivalences fail to preserve differences necessary for explanation, prediction, historical reconstruction, intervention, or cross-domain correction.

The trigger can produce several kinds of revision. GRE may narrow a relational claim, split one object category into several, merge previously distinct categories for a limited task, import a domain-specific ontology, weaken an identity criterion, revise the relation among ontological, relational, and manifestational registers, or abandon a stronger commitment that no longer performs defensible explanatory work. The three-register architecture itself remains open to such revision. Its present usefulness gives it standing within the research programme, not immunity from future counter-argument.

The ontological limits developed in this section therefore strengthen rather than empty GRE's commitments. The programme can treat historically generated economic objects as real and causally consequential, distinguish their manifestations from the realities they participate in, analyze multiple realizations, and place relations at the center of inquiry without converting these achievements into a closed metaphysics. The limitation grammar also identifies where failure could occur: relational-reality attributions can be weakly evidenced, manifestations can underdetermine constitution, stronger ontologies can exceed their warrant, domain ontologies can resist transfer, intrinsic or differently constituted properties can outperform relational accounts, and task-relative equivalence can be mistaken for identity. The next section turns from these ontological vulnerabilities to the epistemic problem they create: how GRE can responsibly infer relations, histories, mechanisms, and realities when observation is partial, situated, model-dependent, and often structurally indirect.

24.3 Epistemic Limits

The ontological restraint developed in Section 24.2 leaves GRE with a demanding epistemic problem. Economically consequential relations, histories, capacities, constraints, and generative processes can be real enough to matter while remaining only partially accessible to inquiry. The present section identifies the limits created by that gap between a relational target and the evidence available for reconstructing it. Its objective is to distinguish partial observation, latent and hidden relations, historical situatedness, observer participation, model dependence, inverse problems, and reconstruction limits as different epistemic vulnerabilities rather than treating them as one generic uncertainty. The discussion is analytical and methodological. It returns critically to epistemic resources developed earlier in the book and asks how those resources constrain the confidence, granularity, and revisability of GRE claims. Manifestation and representation have their own dedicated limits in the next section; the present concern is the warrant of inference from whatever evidential access is available.

Definition 24.39 (Epistemic limit in GRE). An *epistemic limit in GRE* is a condition under which the evidence, access, inferential bridge, observer position, historical record, or analytical model available to an inquiry does not support the full strength, uniqueness, granularity, or portability of a proposed relational or generative claim.

Definition 24.39 concerns warrant rather than the existence of the target. A weakly observed relation need not be ontologically weak. Conversely, a richly represented object need not be correctly reconstructed. The limitation grammar of Section 24.1 therefore applies at the level of specific epistemic claims: an inquiry should identify where access is incomplete, which alternatives remain live, and what kind of additional evidence could materially change the inference.

Table 24.3 summarizes the principal limits developed in this section and the corresponding discipline they impose on GRE inquiry.

24.3.1 Partial Observation

GRE often studies systems in which no observer has complete access to the relevant relational field. Administrative data may record transactions while omitting informal obligations; interviews may reveal meaning while leaving organizational records inaccessible; platform logs may register interaction while concealing algorithmic ranking; archives may preserve one institution's correspondence while losing another's; longitudinal studies may cover some periods densely and others sparsely. Partial observation is therefore a structural feature of many GRE inquiries rather than an exceptional defect.

The central epistemic problem is coverage. An inquiry can observe many traces and still systematically miss the relations most consequential for the claim. Coverage should consequently be assessed across several dimensions: actors, relation types, temporal intervals, spatial or institutional domains, observational channels, and positions of differential visibility. A large dataset can remain epistemically narrow when all records originate from one institutional vantage point.

Definition 24.40 (Observation-coverage profile). An *observation-coverage profile* records the portions of a relational target that are directly observed, indirectly evidenced, inaccessible, unrecorded, or of uncertain status across the dimensions

Table 24.3: Epistemic limits and corresponding disciplines in GRE inquiry.

Epistemic limit		Core problem	Required discipline
Partial observation		Relevant actors, relations, events, or intervals are observed unevenly	State coverage and visibility conditions; test sensitivity to plausible omissions
Latent relations		A relation may exist without being sufficiently discriminated in the current observation regime	Preserve inferential status and competing explanations
Hidden relations		Access to relevant traces is obstructed, concealed, or institutionally restricted	Require evidence of obstruction as well as evidence for the proposed relation
Historical	situated-	What can be known depends on historically changing categories, records, institutions, and access	Index claims to the evidential horizon and reconstruct changing conditions of knowability
ness			
Observer	participa-	Inquiry can alter access, behavior, disclosure, or the target relation itself	Record participation pathways and distinguish observation, elicitation, and intervention
tion			
Model dependence		Inference depends on analytical choices that privilege some structures over others	Compare substantively plausible models and report conclusions that are model-sensitive
Inverse problems		Multiple relational configurations can remain compatible with the same evidence	Retain compatibility classes and seek discriminating evidence rather than forced uniqueness
Reconstruction limits		Some histories or mechanisms remain permanently underdetermined	State recoverable cores, irrecoverable remainders, and the strongest warranted level of claim

materially relevant to a specified claim.

The profile in Definition 24.40 should be claim-specific. A study of payment dependence may require dense transactional coverage but limited access to subjective meaning. A study of trust formation may require precisely the opposite. A historical study of institutional conversion may need temporal continuity more than contemporaneous breadth. The relevant question is therefore whether the observed field adequately covers the mechanism being claimed, rather than whether observation is complete in an abstract sense.

Partial observation becomes especially dangerous when missingness is patterned. Relations involving informal work, marginalized actors, confidential coordination, private care, failed transactions, abandoned projects, or politically weak organizations may leave fewer durable records than highly formalized relations. A reconstruction based on the surviving traces can then mistake observability for prevalence or institutional legibility for causal importance.

Proposition 24.41 (Coverage-sensitive inference). *The warranted strength of a GRE*

claim should decrease when plausible changes to unobserved or weakly observed portions of the target would materially alter the claimed relation, mechanism, or generative consequence.

Proposition 24.41 does not imply that incomplete observation prevents strong inference. Some conclusions remain stable across wide ranges of plausible missingness. Others concern directly observed institutional relations whose relevant properties are well documented. The epistemic requirement is sensitivity: an inquiry should identify whether its conclusion survives realistic alternative reconstructions of the unobserved portions of the field.

24.3.2 Latent Relations

A relation can be relationally consequential while remaining insufficiently discriminated within the current observation regime. Earlier chapters used *latent relation* for such cases. The epistemic limitation is subtle because latency is compatible with several states of affairs: a relation can be weakly manifested, manifested only under particular conditions, evidenced indirectly through consequences, or represented by traces that fail to distinguish it from rival relations.

GRE should therefore avoid treating latency as a synonym for invisible truth. A latent relation is an inferential candidate whose warrant depends on the structure connecting proposed relation, expected traces, observed traces, and alternatives. A recurring co-movement between organizations, for example, may be compatible with direct coordination, exposure to a common regulation, shared professional norms, imitation, or a common external shock. The proposed relation becomes better identified when the inquiry finds evidence that discriminates among these possibilities.

Definition 24.42 (Latent-relation warrant profile). *A latent-relation warrant profile records the proposed relation, the indirect or conditional traces supporting it, serious alternative explanations, observations that would discriminate among those alternatives, and the consequences of misidentification for the substantive GRE claim.*

The last component is important. Misidentifying a latent relation can have different consequences depending on the argument. If several candidate relations all imply the same broader dependence structure, the higher-level conclusion may remain robust even when the precise relation is unresolved. If the distinction determines whether an intervention targets trust, coercion, regulation, or shared exposure, the unresolved latency is much more consequential.

Proposition 24.43 (Latent-structure restraint). *GRE may infer a latent relational property at a level supported across plausible explanations while leaving more specific relational constitution unresolved.*

Proposition 24.43 permits epistemic progress under underdetermination. The appropriate response to a non-unique reconstruction is often to identify what is common to the viable accounts rather than to select one complete story prematurely.

24.3.3 Hidden Relations

Hidden relations differ from merely latent relations because access to relevant evidence is materially obstructed. The obstruction can arise through strategic concealment, confidentiality, secrecy, proprietary control, institutional exclusion, selective

preservation, inaccessible infrastructures, language barriers, or the absence of channels through which some actors can produce recognized evidence. Hiddenness is therefore relational to an observation regime and to the distribution of epistemic access.

The concept carries a distinctive risk. Because the relation is partly hidden, an investigator can be tempted to treat the absence of confirming evidence as evidence of concealment. That move makes the hypothesis difficult to challenge. GRE should therefore require independent support for the obstruction mechanism as well as support for the substantive relation being proposed.

Definition 24.44 (Hidden-relation access profile). A *hidden-relation access profile* specifies the proposed relation, the expected evidential channels, the mechanisms restricting or distorting access to those channels, the traces of obstruction, and the alternative explanations compatible with the observed absence or irregularity.

Evidence of obstruction can include documented access restrictions, asymmetric record retention, unexplained deletion, legal confidentiality, restricted technical interfaces, contradictory public and private records, testimony concerning concealment practices, or systematic differences between groups in whose relations become institutionally visible. None of these automatically proves the hidden relation. They establish that non-observation should be interpreted through an access mechanism rather than treated as a neutral absence.

Proposition 24.45 (Dual burden for hidden relations). A GRE claim about a hidden relation carries two evidential burdens: support for the proposed relation and support for the process that limits ordinary access to its traces.

The dual burden in Proposition 24.45 is especially important in studies of power, capture, collusion, dependency, discrimination, and informal governance. These phenomena can genuinely involve concealment, yet their seriousness does not relax the evidential requirement. The framework should make hiddenness investigable without making it self-confirming.

24.3.4 Historical Situatedness

Economic knowledge is produced from historically situated evidence. Categories change, archives survive selectively, institutions alter recordkeeping, actors possess different concepts, technologies change what can be observed, and later researchers gain access to information unavailable to contemporaries while losing contextual knowledge that contemporaries took for granted. Epistemic limits are therefore indexed to time as well as to observer position.

Historical situatedness has at least two directions. A retrospective inquiry can know outcomes that earlier actors could not know, creating hindsight effects in the interpretation of decisions. At the same time, the retrospective inquiry can lose tacit context, routine knowledge, informal classifications, unrecorded alternatives, and records that did not survive. Later knowledge is consequently different from contemporaneous knowledge rather than uniformly superior to it.

Definition 24.46 (Historical epistemic horizon). A *historical epistemic horizon* is the set of evidence, categories, methods, access conditions, expectations, and background knowledge reasonably available to a specified actor or inquiry at a specified historical time and location.

The horizon in Definition 24.46 allows GRE to distinguish at least three questions: what actors could reasonably know at the time, what later researchers can reconstruct about their situation, and what contemporary theory can infer using concepts unavailable to those actors. These questions can yield different answers. A policy can be historically understandable under one information set and still be criticized under evidence then available but institutionally ignored. Conversely, later reconstruction can become overconfident when outcomes make one path look inevitable.

Proposition 24.47 (Historically indexed warrant). *Claims about historical knowledge, expectation, responsibility, or feasible choice should be evaluated relative to the relevant historical epistemic horizon rather than solely through the information available to later inquiry.*

Historically indexed warrant also constrains concept transfer. A category such as unemployment, disability, market power, citizenship, household, or intelligence can change in legal definition, administrative measurement, social meaning, and practical consequence. A time series may preserve a label while the object measured by that label changes. Historical epistemic discipline therefore requires reconstruction of category conditions as well as reconstruction of events.

24.3.5 Observer Participation

Observers can participate in the systems they study. Interviewers elicit accounts; ethnographers become recognized presences; surveys define answer categories; audits change organizational behavior; researchers request records that institutions assemble for the first time; experiments alter constraints; policy evaluations affect expectations; and publication can redirect subsequent attention. Observer participation is consequently a source of both epistemic access and epistemic transformation.

Participation should be distinguished from the performativity of representations discussed in the next section. The present issue concerns the observer's relation to evidence production and to the target system. A researcher can alter behavior before any formal representation is published. Participants can disclose information because trust develops, conceal information because observation becomes salient, or reorganize practices in response to being studied. These changes can reveal existing relations, create new relations, or do both.

Definition 24.48 (Observer-participation profile). An *observer-participation profile* records the observer's access, role, permissions, dependencies, elicitation methods, interventions, expected behavioral effects, and the pathways through which inquiry can alter the evidence or relational target relevant to a specified claim.

The profile resists two symmetrical errors. Treating the observer as external can hide constitutive features of the evidence-production process. Treating participation as disqualifying can discard knowledge available only through engagement. GRE instead requires the inferential consequences of participation to be made explicit.

Definition 24.49 (Discovery-creation ambiguity). *Discovery-creation ambiguity* arises when an observational or research intervention produces evidence compatible both with revealing a previously existing relation and with creating or strengthening the relation through the intervention itself.

Consider a coordination exercise that reveals actors can cooperate once a shared forum is provided. The result may disclose latent cooperative capacity, generate

a new coordination relation, or combine both mechanisms. The economic consequences can be important in each case, but their historical and causal interpretation differs. GRE should therefore avoid treating post-intervention observability as uncomplicated evidence of pre-intervention existence.

Proposition 24.50 (Participation-aware inference). *When inquiry materially participates in evidence production, GRE should distinguish conclusions about the pre-observation system, the observer–system relation, and the system that exists after participation.*

24.3.6 Model Dependence

Relational evidence rarely enters analysis without modeling choices. Researchers decide which actors count as nodes, which interactions count as relations, how time is discretized, where system boundaries are placed, which categories are merged, which latent variables are introduced, how missingness is treated, and which mechanisms are admissible. Qualitative reconstruction is also model-dependent in this broader sense: a narrative selects events, causal links, temporal scales, and interpretive categories even when no mathematical model is used.

Model dependence becomes an epistemic limit when a substantive conclusion changes materially across several plausible analytical specifications. The existence of such dependence does not imply that models are arbitrary. Some specifications can be better supported by theory, evidence, institutional knowledge, or predictive and explanatory performance. The limitation concerns claims whose apparent stability derives mainly from one unexamined modeling frame.

Definition 24.51 (Model-dependence register). *A model-dependence register records the analytical choices that materially structure a GRE inference, the plausible alternatives to those choices, and which substantive conclusions remain stable, weaken, change sign, or disappear across those alternatives.*

The register should include conceptual as well as statistical choices. A study can be model-dependent because it represents a household as a unit rather than as an internal relation, treats a platform as a firm rather than as infrastructure, defines participation through formal membership, or chooses a short time horizon that suppresses delayed generative effects. Such choices can be analytically defensible while still delimiting what the resulting claim means.

Proposition 24.52 (Robustness without model neutrality). *A conclusion that remains stable across substantively plausible models has stronger cross-model warrant, while stability alone does not establish that the shared assumptions of those models are correct.*

Proposition 24.52 is important because a family of models can reproduce the same blind spot. Several analyses can rely on the same administrative categories, the same boundary convention, or the same assumption that unobserved relations are negligible. Robustness should therefore be evaluated both within a model family and against alternatives that challenge its shared structure where those alternatives are substantively plausible.

24.3.7 Inverse Problems

The epistemic architecture of GRE repeatedly generates inverse problems. Inquiry commonly begins with observed outcomes, traces, records, classifications, interactions, or manifestations and asks which relational configuration or historical trajectory could have generated them. Even perfectly recorded evidence can remain compatible with several different underlying relations. The limitation is therefore underdetermination of reconstruction rather than measurement error alone.

An inverse problem should be stated in terms of a compatibility class. The relevant epistemic object is not always one reconstructed relation, but the set of reconstructions still admissible after the available evidence and defensible assumptions have been applied. Evidence can improve knowledge by shrinking that class, separating families of explanations, identifying common structure, or ruling out mechanisms even when unique inversion remains unavailable.

Definition 24.53 (Reconstruction compatibility class). *A reconstruction compatibility class is the set of relational configurations or historical trajectories that remain substantively compatible with a specified evidential record under the assumptions and inferential bridges adopted by an inquiry.*

The compatibility class in Definition 24.53 should remain tied to the claim and to the inquiry's assumptions. Adding an archival source, changing a boundary, relaxing a behavioral assumption, or incorporating testimony can change the class. The goal is therefore not to calculate one universal set of possibilities, but to make visible how evidential and theoretical choices constrain the surviving explanations.

Definition 24.54 (Discriminating evidence). *Discriminating evidence is evidence whose expected pattern differs materially across two or more serious candidate reconstructions and can therefore reduce the reconstruction compatibility class.*

Discriminating evidence can be historical, qualitative, institutional, quantitative, experimental, or formal. A contractual clause can distinguish authorized dependence from informal convention; timing can distinguish imitation from common shock; an intervention can separate capacity from routine non-use; testimony can reveal meaning absent from transaction logs; a newly opened archive can rule out an assumed causal sequence. Methodological pluralism is therefore especially useful in inverse problems because different methods can supply different discriminating traces.

Proposition 24.55 (Inference from reconstruction invariants). *When several serious reconstructions remain admissible, GRE may warrant claims about relational properties shared across those reconstructions more strongly than claims selecting one complete reconstruction.*

This proposition supplies a disciplined alternative to forced uniqueness. If every plausible account of an institutional failure contains concentrated control over one conversion interface, the concentration claim can be robust even when the exact historical mechanism remains disputed. Such partial invariants can support explanation and intervention while preserving uncertainty about the fuller relational history.

24.3.8 Limits of Reconstruction

Some epistemic losses are recoverable through additional evidence, better access, new methods, or later disclosure. Others may be permanent. Records were never created; participants are unavailable; meanings were tacit; institutional categories

erased distinctions; material traces disappeared; or several historical sequences remain observationally equivalent after every surviving source has been examined. GRE therefore requires a concept of bounded reconstruction that treats irrecoverability as theoretical content rather than as an embarrassment to be hidden by narrative completeness.

Definition 24.56 (Reconstruction adequacy profile). A *reconstruction adequacy profile* states, for a specified claim, which actors, relations, mechanisms, temporal sequences, contexts, and counterfactual alternatives are well supported, weakly supported, unresolved, or probably irrecoverable, together with the inferential consequences of each status.

Adequacy is therefore task-relative. A reconstruction can be inadequate for attributing responsibility to one actor while adequate for identifying the institutional structure that made a class of outcomes possible. It can be inadequate for estimating the exact magnitude of a generative effect while adequate for establishing that one conversion pathway existed. It can be inadequate for recovering subjective meaning while adequate for reconstructing formal authority. The strongest defensible claim should track the dimension that is actually recoverable.

Definition 24.57 (Irrecoverable epistemic remainder). An *irrecoverable epistemic remainder* is a materially relevant aspect of a relational target for which the surviving evidence and realistically available future evidence do not presently permit a warranted reconstruction at the resolution required by the desired claim.

Calling a remainder irrecoverable should itself be cautious. Archives can open, technologies can improve, participants can disclose new material, and apparently lost traces can be rediscovered. The designation is therefore indexed to presently realistic access conditions rather than asserted as metaphysical impossibility. Its analytical purpose is to prevent current gaps from being filled silently by theoretical preference.

Proposition 24.58 (Bounded reconstruction). *GRE can support strong relational and generative claims without complete reconstruction when the claim is confined to properties warranted across the recoverable evidence and plausible reconstruction range, and when materially unresolved dimensions remain explicit.*

Bounded reconstruction prevents two opposite errors. One is epistemic maximalism, in which a coherent narrative is mistaken for uniquely recovered history. The other is generalized skepticism, in which non-unique reconstruction is treated as preventing useful knowledge altogether. GRE can occupy the middle position by identifying robust structure, reporting unresolved alternatives, and calibrating the granularity of its conclusions.

Definition 24.59 (Epistemic revision trigger). An *epistemic revision trigger* is new evidence, access, methodological criticism, model comparison, historical recontextualization, or demonstrated observer effect that materially changes the observation-coverage profile, reconstruction compatibility class, or warranted confidence of a GRE claim.

The revision trigger connects epistemic limits to the open research programme. A newly available archive can contract a compatibility class. Discovery of shared data provenance can weaken apparent triangulation. A rival model can reveal specification dependence. Evidence of observer effects can reclassify an apparent pre-existing relation as partly intervention-generated. Newly recognized historical categories can change the interpretation of older measurements. These developments should prop-

agate into the claims that depended on the earlier epistemic state rather than remain isolated methodological footnotes.

The epistemic limits developed in this section therefore concern the architecture of warranted access. Observation can be partial and asymmetrically distributed; relations can be latent or hidden; historical actors and later researchers can occupy different epistemic horizons; observers can participate in producing the evidence they analyze; conclusions can depend on model architecture; inverse problems can admit multiple viable reconstructions; and some aspects of relational history can remain unresolved after responsible inquiry. None of these conditions entails generalized skepticism. They specify where GRE should lower claim strength, preserve alternatives, search for discriminating evidence, or state an irrecoverable remainder. The next section turns to a closely related but distinct problem: manifestations and representations can themselves distort, compress, classify, and recursively alter the relational realities through which evidence becomes available.

24.4 Manifestation and Representation Limits

Section 24.3 treated epistemic limits as limits of access, evidence, model dependence, and reconstruction. The present section examines a related but distinct source of difficulty: the processes through which relational differences become manifest and the representational forms through which those manifestations are subsequently encoded, classified, measured, narrated, modeled, or symbolized. Its objective is to identify limitations introduced by manifestation and representation themselves rather than by incomplete observation alone. The discussion returns critically to the manifestation architecture of Chapters 4–5 and asks how non-invertibility, manifestational equivalence, representation error, performative uptake, symbolic overreach, classification effects, changing manifestation relations, and reverse inference constrain GRE claims. The method is reconstructive and failure-sensitive. Existing concepts are retained where they remain adequate, but their limitations are made explicit and connected to the limitation grammar of Section 24.1.

Manifestation and representation should remain analytically distinct. Chapter 4 defined manifestation broadly as the process through which a difference becomes sufficiently differentiated and available within a manifestational configuration. Representation is narrower: it organizes selected manifestations into symbolic, linguistic, administrative, legal, statistical, computational, visual, or other forms that can stand for, classify, compare, preserve, or operationalize a target. A manifestation can therefore occur without a representation, while a representation ordinarily depends on some prior or concurrent manifestational availability. Both layers can alter what later becomes knowable and actionable.

Definition 24.60 (Mediation limit). A *manifestation-representation limit* is a condition under which the processes that render a relational difference manifest or the representations constructed from those manifestations omit, compress, transform, conflate, stabilize, amplify, or recursively alter target-relevant structure in ways that restrict warranted inference or change the relational system being analyzed.

Definition 24.60 contains two families of limitation. The first concerns the manifestation relation itself: several relational configurations can become manifest in similar forms, one configuration can manifest differently under different conditions, and

Table 24.4: Manifestation and representation limits in GRE inquiry.

Limit	Core problem	Required discipline
Non-invertibility	Manifest form does not uniquely recover antecedent relational structure	Retain compatible antecedents and seek discriminating evidence
Manifestational equivalence	Relationally different configurations are indistinguishable under an operative manifestation regime	State the equivalence criterion and the distinctions it suppresses
Representation error	Encoding or interpretation fails to preserve target-relevant structure	Evaluate error relative to target, use, scale, and representational genealogy
Performative representation	Uptake of a representation changes the system it purports to describe	Separate descriptive adequacy from causal efficacy and trace feedback
Symbolic overreach	Symbolic precision or authority exceeds warranted target correspondence	Match semantic strength to the evidence connecting symbol and target
Classification effects	Categories alter eligibility, recognition, behavior, or later data generation	Treat consequential classification as both representation and intervention
Changing manifestation relations	The rule linking target and manifestation changes over time or context	Reconstruct mapping change before interpreting manifest change as target change
Reverse-inference limit	Available manifestations and representations support only bounded reconstruction	State the strongest invariant claim and preserve unresolved alternatives

the mapping can change historically. The second concerns representation: symbolic forms can introduce target-relative error, acquire unwarranted semantic authority, classify cases consequentially, or become performative through institutional uptake. These families interact, but neither should be reduced to the other.

Table 24.4 summarizes the principal limitations developed below.

24.4.1 Non-Invertibility

Chapter 4 established manifestational non-invertibility as a local property of an inquiry: an available manifestation need not support unique and warranted recovery of the antecedent relational configuration at the scale required by the question. The present limitation is not merely that information is missing. Manifestation itself can compress, aggregate, classify, normalize, or reorganize differences so that distinct antecedents become compatible with the same manifest form. Additional observation can improve inference without necessarily restoring what the manifestation process has already erased.

A precise market price, administrative score, legal status, institutional category, behavioral regularity, or statistical indicator can therefore be highly determinate as a manifestation while remaining underdeterminate as evidence of generative history. The distinction matters because standardized forms often invite reverse inference. A wage may be interpreted as revealing productivity, a test score as revealing learn-

ing, a price as revealing value, a formal title as revealing practical authority, or an observed choice as revealing stable preference. GRE should instead ask which relational configurations remain compatible with the manifested form under the operative mapping conditions.

Definition 24.61 (Inversion-adequacy profile). An *inversion-adequacy profile* records the manifestation used for reverse inference, the manifestation relation believed to have generated it, the materially distinct antecedent configurations that remain compatible with the manifestation, the evidence available for discriminating among them, and the resolution at which reconstruction becomes warranted or remains non-unique.

The profile prevents a binary understanding of invertibility. Reverse inference can be adequate for one property and inadequate for another. A registry entry may uniquely establish a legally recorded status while leaving practical dependence, social recognition, bargaining history, or subjective meaning unresolved. A measured output may identify that a process occurred while failing to identify which mechanism produced it. The relevant question is therefore not whether a manifestation has an inverse in the abstract, but which target properties can be recovered with what warrant.

Proposition 24.62 (Non-invertibility floor). *When materially different antecedent relational configurations remain compatible with the available manifestations after serious use of accessible discriminating evidence, GRE should not infer a more specific antecedent than the properties shared across the remaining compatibility class.*

Proposition 24.62 is a restraint on explanatory granularity. It does not prohibit causal interpretation. It requires the causal claim to stop at the level warranted across serious alternatives. Where several histories all contain concentrated gatekeeping but differ in whether that gatekeeping arose through law, organizational convention, technical architecture, or strategic coordination, the concentration may be well supported while the precise historical mechanism remains open.

24.4.2 Manifestational Equivalence

Non-invertibility becomes particularly important when an operative manifestation regime treats relationally distinct configurations as equivalent. Equality at the level of manifestation can arise because the regime deliberately ignores certain distinctions, because its resolution is insufficient to register them, or because different histories converge on forms that satisfy the same classificatory or observational criterion. The resulting equivalence is always indexed to a manifestation regime and an analytical purpose.

Definition 24.63 (Claim-relative manifestational equivalence). Two relational configurations are *claim-relatively manifestationally equivalent* when the operative manifestation regime renders them indistinguishable with respect to the manifested properties used by a specified claim, even though the configurations differ in one or more relational properties outside that manifestational criterion.

This definition avoids treating equivalence as identity. Two households can have the same measured income while differing sharply in debt, care obligations, security, informal support, legal status, or exposure to risk. Two organizations can report the same productivity indicator while relying on different labor processes. Two students can receive the same score through different learning trajectories. Two political

economies can produce the same aggregate growth rate while distributing capabilities and vulnerabilities very differently. The manifestation regime can legitimately treat such cases as equivalent for one narrow purpose without authorizing equivalence for another.

Definition 24.64 (Suppressed-difference register). A *suppressed-difference register* identifies relational distinctions that are intentionally or unintentionally treated as equivalent by a manifestation regime and records which GRE claims would become invalid or incomplete if those suppressed differences proved materially consequential.

The register makes manifestational equivalence auditable. It is especially useful where policy, administration, markets, or research systems depend on standardized categories. Standardization can enable coordination and comparison, yet the same standardization can erase differences relevant to justice, generativity, vulnerability, or causal mechanism. GRE need not reject standardized manifestations. It should specify what the standard preserves and what it makes unavailable.

Proposition 24.65 (Equivalence-scope discipline). *Manifestational equivalence warrants substitution between cases only for claims whose target-relevant distinctions are preserved by the operative equivalence criterion.*

The proposition prevents a common inferential expansion in which equivalence established for measurement or administration becomes equivalence for explanation, value, responsibility, or intervention. A shared category can support aggregation without supporting identical treatment in every downstream domain.

24.4.3 Representation Error

Chapter 5 defined representation error as a target-relative discrepancy introduced when a representation omits, distorts, conflates, misclassifies, mis-scales, or otherwise preserves inadequately a feature material to the claim for which the representation is used. The present section treats that definition as an internal limitation of GRE because GRE itself depends heavily on relational maps, histories, categories, tables, formal structures, models, diagrams, indicators, and narratives. Representational failure can therefore arise not only in the economic systems GRE studies but also in GRE's own research practice.

Several distinctions deserve preservation. Selection error concerns which relations or cases enter the representation. Classification error concerns how they are grouped. Aggregation error concerns structure lost through combination. Semantic error concerns a mismatch between symbol and interpreted relation. Temporal error concerns treating a representation as current after its target has changed. Structural error concerns imposing a representational form that does not preserve the relevant organization, such as forcing a higher-order or temporally evolving relation into a static pairwise graph.

Definition 24.66 (Representation-error profile). A *representation-error profile* records the target, representational purpose, encoding rules, preserved features, omitted features, plausible error modes, error genealogy, sensitivity of the substantive claim to those errors, and available routes of correction or alternative representation.

The genealogy component is important because apparently independent represen-

tations can inherit the same upstream categories or records. Several datasets can agree because each reproduces one administrative classification. Several models can appear robust because each uses the same proxy. Several historical accounts can converge because they draw from the same archive created under one institutional visibility regime. Agreement among representations should therefore be evaluated partly by the independence of their representational histories.

Proposition 24.67 (Correlated representation-error condition). *Agreement among several representations provides weaker corroboration when their target-relevant errors are plausibly correlated through shared categories, data-generating processes, institutional procedures, or inherited representational assumptions.*

This condition connects representation limits with the triangulation discipline of Chapter 5. Heterogeneous methods are valuable not merely because there are several of them, but because they can fail differently. A qualitative account, administrative record, legal document, network representation, and historical archive can strengthen one another when they provide partially independent access to the relevant structure. Multiplication of representations derived from one upstream schema does not create the same epistemic gain.

Representation error should also be propagated rather than quarantined. If a value-conversion claim depends on a classification that later proves too coarse, or a power claim depends on an indicator whose semantics have shifted, the downstream claim should be reconsidered. This is one reason the versioned research infrastructure developed in Chapter 22 matters: correction requires knowledge of which conclusions depended on which representational state.

24.4.4 Performative Representation

Representations can exceed the role of passive description. A score can affect eligibility; a forecast can alter investment; a ranking can redirect attention; a legal representation can change rights and duties; a risk category can alter monitoring; a model output can influence policy; an AI-generated summary can shape expectations. When uptake of the representation changes later relations, the representation becomes part of the generative-relational system it helps describe.

This performativity creates a distinctive limitation because descriptive adequacy and causal efficacy can diverge. A representation can be inaccurate yet consequential. Once institutions act on it, later observations may partly reflect the representation's effects rather than the antecedent structure the representation originally purported to track. A prediction can help produce the outcome later treated as confirmation. A category can organize behavior around its boundaries. A metric can redirect effort toward measured dimensions and away from unmeasured ones.

Definition 24.68 (Representational uptake pathway). *A representational uptake pathway records the representation, the positions or institutions that encounter it, the authority or practical standing attributed to it, the decisions or actions conditioned by that uptake, and the subsequent relational changes through which the representation becomes causally consequential.*

The pathway distinguishes circulation from effect. A representation can be widely visible yet practically ignored. Another can be encountered by few actors but possess decisive authority at a gatekeeping point. The relevant variable is not exposure alone but the relation between representation, standing, decision, and subsequent configu-

ration.

Definition 24.69 (Reflexive representational loop). A *reflexive representational loop* occurs when a representation affects later relational conditions in ways that materially alter the manifestations or data subsequently used to evaluate, reproduce, or revise that representation or a related representational scheme.

Reflexive loops complicate validation. If a credit category restricts access and later low asset accumulation is used to validate the category, the observed association can contain effects produced by prior classification. If a ranking directs attention and later attention is treated as evidence of rank quality, the evaluation is partly endogenous to the ranking. GRE should therefore reconstruct whether the evidence used for validation was generated before, independently of, or partly through uptake of the representation.

Proposition 24.70 (Performativity does not validate representation). *The causal efficacy, institutional persistence, or self-reinforcing reproduction of a representation does not by itself establish the representation's epistemic adequacy, normative desirability, or ontological correctness.*

This proposition restates, as a limitation principle, the recursive architecture of Chapter 4. A representation can become relationally real because it is persistently used and causally efficacious while remaining a poor account of the antecedent target. GRE must therefore be able to analyze the reality of a representation's effects without endorsing the representation's truth or legitimacy.

24.4.5 Symbolic Overreach

Symbolic systems enable memory, comparison, formalization, communication, and cumulative inquiry. They also create a recurring temptation: the determinacy of the symbol can be mistaken for determinacy of the target. Exact numerical values, sharply bounded categories, formal notation, legal terminology, diagrams, model parameters, and computational outputs can appear more settled than the manifestation and relational structures they represent.

Definition 24.71 (Symbolic overreach). *Symbolic overreach* occurs when the precision, granularity, stability, scope, inferential authority, or ontological implication attributed to a symbol or symbolic system exceeds the warrant supplied by the manifestation and representation relations connecting that symbol to its target.

Symbolic overreach can be quantitative or qualitative. Reporting a coefficient to several decimal places can overstate measurement stability. Assigning a sharply defined category can overstate the clarity of a boundary. Using a mathematical object can suggest stronger structural correspondence than has been demonstrated. A legal or administrative label can be treated as if it exhausted practical identity. A graph can suggest discrete nodes and edges where the empirical phenomenon is distributed, higher-order, contested, or temporally unstable. The issue is not the use of symbols. It is the transfer of symbolic properties to the target without an adequate bridge.

Definition 24.72 (Symbolic-determinacy gap). A *symbolic-determinacy gap* is the difference between the degree of determinacy encoded or displayed by a representation and the degree of target-level determinacy warranted by the evidence, manifestation relation, and representational semantics available for the relevant claim.

The gap provides a useful diagnostic for formal GRE. A formal model can be exactly

specified while its empirical objects remain partly identified. This is not necessarily a defect: exact formal structure can clarify assumptions and consequences. The limitation arises when formal exactness is cited as evidence that the world shares the same exactness. A later section will examine formalization limits directly; the present point concerns the representational bridge on which those formalisms depend.

Proposition 24.73 (Semantic-strength constraint). *The semantic and inferential strength assigned to a GRE symbol should not exceed the strongest target correspondence that has been independently justified for the inquiry in which the symbol is used.*

This constraint protects notation from becoming a substitute for argument. A symbol can remain useful under weaker semantics. A variable can be explicitly operational rather than ontological; a network edge can represent documented interaction rather than an exhaustive relation; an amplitude-like object can remain a formal analogy rather than an empirically identified physical quantity. Making the semantics weaker and clearer can improve rather than diminish the analysis.

24.4.6 Classification Effects

Classification is a particularly important case because it can occupy several analytical roles at once. A category can describe an already manifest difference, compress several differences for administrative use, determine eligibility, distribute recognition, guide intervention, alter self-understanding, or shape the production of later records. Classification can therefore be simultaneously representational, institutional, and generative.

A classification error and a classification effect should remain distinct. A case can be correctly assigned according to an operative rule while the rule itself produces consequential effects. Conversely, a category can be epistemically poor while its institutional enforcement remains powerful. GRE needs to analyze both the adequacy of the classification and the relations generated through its use.

Definition 24.74 (Classification-effect profile). *A classification-effect profile records the category system, classificatory rule, authority of application, represented target, positions classified, consequences of assignment, available contest routes, behavioral or institutional responses, effects on later data generation, and conditions under which the classification can be revised or exited.*

The profile makes classification temporally recursive. A category applied at one moment can change access, incentives, visibility, expectations, or organizational treatment. Those changes can alter the later characteristics observed in the classified population. If the later characteristics are then used to justify the classification without accounting for the intervention, the representational and causal roles become circular.

Proposition 24.75 (Classification-intervention condition). *When assignment to a category materially changes a classified position's feasible actions, recognition, resources, obligations, exposure, or future manifestations, the classification should be analyzed as an intervention in addition to being evaluated as a representation.*

This condition is relevant to economic categories, educational tracks, credit ratings, labor classifications, risk scores, legal statuses, welfare eligibility, organizational performance groups, and many other settings. It does not imply that consequential clas-

sification is illegitimate. It requires the inquiry to include the downstream effects of classification in the object of analysis.

Classification can also affect what becomes visible. Institutions often collect different information after a case enters a category. Monitoring may intensify for one group and weaken for another. Record systems can add fields for recognized categories while leaving unrecognized experiences unrecorded. Classification effects therefore reach back into epistemology by reshaping the manifestation regime through which later evidence is generated.

24.4.7 Changing Manifestation Relations

A manifestation relation need not remain fixed while the target changes. Measurement technologies evolve, administrative categories are revised, legal thresholds shift, reporting incentives change, institutional coverage expands, actors learn to respond strategically, cultural meanings change, and computational systems are updated. The same observed label or numerical series can therefore be generated by different manifestation relations at different times.

Chapter 5 already emphasized that observed change can reflect change in the relational target, change in the manifestation relation, or interaction between both. The limitation becomes especially serious for longitudinal GRE because historical analysis often relies on records whose apparent continuity exceeds the continuity of the conditions under which they were produced.

Definition 24.76 (Manifestation-regime drift). *Manifestation-regime drift* is a change over time or across contexts in the rules, mediators, thresholds, technologies, incentives, categories, institutional procedures, or scope through which a relational target becomes manifest, such that nominally similar manifestations no longer preserve the same target-relevant relation.

Drift can be gradual or discontinuous. A survey question can retain the same wording while its social meaning changes. A statistical category can preserve its label after eligibility rules are altered. A platform metric can remain visible while the ranking algorithm beneath it changes. A legal status can acquire new practical consequences without a change in terminology. A historical archive can appear continuous while the institutional population entering the archive changes.

Definition 24.77 (Longitudinal manifestation-comparability profile). A *longitudinal manifestation-comparability profile* records the periods or contexts being compared, the manifestation relations operating in each, known changes in rules or implementation, plausible strategic responses, preserved and non-preserved semantics, and the level of comparison that remains warranted after those changes are considered.

The profile can support several outcomes. Some changes can be recalibrated through overlapping measurements or conversion rules. Some permit only coarse comparison. Others create a genuine break after which one continuous series should not be interpreted as a single unchanged variable. Documented non-comparability is itself a valid result.

Proposition 24.78 (Mapping-change attribution discipline). *GRE should attribute change to a relational target only to the extent that serious alternatives involving change in the manifestation relation have been excluded, bounded, or incorporated into the claim at the resolution required by the inquiry.*

The discipline is particularly important where institutions respond to measurement. A change in reported behavior can arise because the behavior changed, because the reporting rule changed, because incentives to report changed, because classification changed, or because actors adapted to the measurement regime. Historical and comparative inference should therefore treat the manifestation mapping as a possible moving component of the system.

24.4.8 Limits of Reverse Inference

The preceding limits converge on reverse inference. GRE frequently begins with manifestations and representations: prices, records, scores, legal statuses, interviews, archives, classifications, measurements, network traces, model outputs, narratives, or institutional decisions. The analytical task is to infer something about relational structure, generative mechanism, historical trajectory, value conversion, power, dependence, or future possibility. Reverse inference is unavoidable. The limitation lies in treating its result as stronger or more unique than the manifestation and representation architecture permits.

Reverse inference becomes especially fragile when several limitations combine. A manifestation can be non-invertible; the operative representation can contain systematic error; the classification can change later behavior; the manifestation regime can drift; and the symbolic form can display more precision than the target warrants. These are not independent technical nuisances. Their interaction can create a reconstruction that is internally coherent and institutionally persuasive while remaining weakly connected to the antecedent relational reality.

Definition 24.79 (Reverse-inference dossier). A *reverse-inference dossier* records the target claim, manifestations used, representations constructed from them, relevant manifestation relations, known non-invertibilities and equivalences, representation-error profiles, performative or classificatory feedback, manifestation-regime changes, serious antecedent alternatives, discriminating evidence, and the strongest claim that remains invariant across those considerations.

The dossier integrates rather than replaces the epistemic profiles of Section 24.3. Observation coverage asks which evidence is available. The reverse-inference dossier asks what transformations the available evidence has already undergone and what causal effects those representational forms may have produced. The two inquiries are complementary. Better access does not solve a poor manifestation mapping, while an excellent representation cannot compensate for evidence that never existed or remains inaccessible.

Definition 24.80 (Bounded reverse inference). *Bounded reverse inference* is inference from manifestations or representations to relational properties that remain warranted across the serious manifestation mappings, representational uncertainties, feedback pathways, and antecedent configurations compatible with the available evidence, while leaving stronger non-invariant properties unresolved.

Bounded reverse inference parallels bounded reconstruction in Proposition 24.58. The distinction is that the present concept makes the mediating role of manifestation and representation explicit. A price series may support a robust claim about persistent volatility while leaving the underlying composition of expectations unresolved. A legal record may support a claim about recognized status while leaving practical authority unresolved. A classification history may support a claim about institutional

treatment while leaving the represented personal or social identity contested.

Proposition 24.81 (Reverse-inference restraint). *A GRE claim inferred from manifestations or representations should be no more specific than the target-relevant properties that remain stable after plausible non-invertibility, representation error, performative feedback, classification effects, and manifestation-regime change have been taken into account.*

This proposition does not demand exhaustive skepticism before every empirical claim. It demands proportional scrutiny. A narrow, directly institutional claim may require little reconstruction. A strong claim about latent power, long-run generativity, historical mechanism, or relational ontology requires more. The relevant burden increases with inferential distance between manifest evidence and the target claim.

Definition 24.82 (Manifestation-representation revision trigger). *A manifestation-representation revision trigger is evidence that materially changes the understood mapping between relational target, manifestation, representation, or representational uptake in a way that alters the warrant, interpretation, comparability, or causal status of a GRE claim.*

Examples include discovery that a statistical series changed definition, evidence that an apparently descriptive category altered the behavior later used to validate it, recognition that several data sources inherited the same coding error, demonstration that a formal symbol was being interpreted more strongly than its empirical semantics permit, or recovery of an alternative manifestation that distinguishes previously equivalent antecedents. Such evidence should propagate through downstream conclusions whose warrant depended on the earlier representational state.

Manifestation and representation limits therefore arise neither because appearances are unreal nor because symbolic mediation is inherently unreliable. Manifestations are real events or states of availability, and representations can be indispensable instruments of inquiry, coordination, memory, and institutional action. Their limitation is structural: manifestation can be non-invertible; different relational configurations can become manifestationally equivalent; representations can introduce target-relative error; representation can become performative; symbolic determinacy can exceed target warrant; classification can change the objects and evidence to which it is later applied; and manifestation relations can drift historically. GRE remains possible under these conditions by treating mappings, representations, and their feedback effects as explicit objects of analysis and by bounding reverse inference to what those objects actually support. The next section turns to limits that arise within relational analysis itself, including boundary and scale dependence, relation identification, persistence, higher-order complexity, field reconstruction, missingness, and the limits of relational reduction.

24.5 Relational Limits

Relational analysis is one of the principal methodological commitments of GRE, but a commitment to relations does not remove the need to specify how relations are delimited, typed, compared, aggregated, and distinguished from the objects and processes they connect. Chapters 4–8 developed relational reality, boundary and scale, relation identity, higher-order relations, fields, relational methods, and generative attribution as constructive resources. The present section returns to those resources critically.

Its role is to identify limits that arise *within relational analysis itself*, after ontological suspension, epistemic access, manifestation, and representation have already been treated separately. The objective is to clarify when a relational explanation depends materially on boundary or scale, when the relation being analyzed is insufficiently identified, when continuity claims exceed the evidence, when higher-order or field language outruns reconstruction, when missing relations reorganize the apparent structure, and when relational vocabulary ceases to discriminate among rival explanations. The section proceeds through boundary dependence, scale dependence, relation identification, relation persistence, higher-order complexity, field reconstruction, missingness, and the limits of relational reduction. Its method is sensitivity-oriented and comparative: a relational claim is tested by varying plausible boundaries, scales, relation definitions, continuity rules, structural orders, and alternative non-relational or mixed explanations while asking which conclusions remain stable.

These limits should not be confused with the epistemic limitations of Section 24.3. A researcher may possess excellent evidence for every observed interaction and still obtain a boundary-dependent network. A relation may be clearly manifested and represented while changing meaning across scale. A complete transaction record may still fail to establish whether repeated transactions constitute dependence, trust, hierarchy, or only recurrent exchange. The problem is therefore not always lack of evidence. It can arise from the architecture of relational description itself.

Definition 24.83 (Relational-analysis limitation). A *relational-analysis limitation* is a condition under which the identification, interpretation, persistence, aggregation, configuration, or explanatory role of a relation depends materially on analytical choices or unresolved structural features such that the resulting GRE claim cannot be transported unchanged across plausible boundaries, scales, relation specifications, temporal criteria, or explanatory decompositions.

Definition 24.83 does not make relational inquiry arbitrary. It requires the dependency to be made inspectable. Some relational claims remain remarkably stable across alternative specifications; others are informative precisely because their instability reveals where the relevant organization changes. The critical mistake is to treat a specification-dependent relational result as though it were specification-free.

Table 24.5 summarizes the principal relational limits developed in this section.

The eight limits are coupled. A boundary decision changes which relations can be missing; a scale decision changes which relations can be identified as persistent; a pairwise representation can create an apparent field whose higher-order organization has been suppressed; and an expansive relational vocabulary can make every omitted mechanism appear relational by definition. GRE therefore needs not only richer relational descriptions but also disciplined stopping rules concerning what relational description can legitimately establish.

24.5.1 Boundary Dependence

Every relational analysis requires a provisional answer to the question of what belongs inside the object of inquiry. Chapter 5 treated boundary selection as an epistemic condition of relational knowledge. The present limitation is stronger: some conclusions change materially when a plausible boundary changes even if evidence within each candidate boundary is excellent. A relation classified as external under one specification can become constitutive under another; a seemingly autonomous

Table 24.5: Relational limits and corresponding GRE responses

Relational object	Characteristic limitation	Required response
Boundary	Material relations cross or constitute the analytical perimeter.	Report boundary logic and test plausible alternatives.
Scale	Relational properties change under aggregation, disaggregation, or cross-level coupling.	State scale and examine scale sensitivity.
Relation type	Observed interaction underdetermines relational meaning or mechanism.	Define endpoints, semantics, direction, temporality, and evidential criteria.
Persistence	Continuity can be asserted despite transformation in participants, rules, or function.	State the continuity criterion and identify discontinuities.
Higher order	Pairwise projections can erase collective or relation-among-relation structure.	Preserve only higher-order structure warranted by the target and evidence.
Field	Distributed conditioning can become a residual label for unexplained context.	Reconstruct positions, boundaries, mechanisms, and rivals.
Missingness	Unobserved relations can alter inferred positions and configurations.	Model missingness relationally and test sensitivity to plausible unseen structure.
Reduction	Relational vocabulary can absorb materially distinct mechanisms without discrimination.	Retain mixed or domain-specific explanatory components where needed.

organization can become dependent when financing, infrastructure, household reproduction, regulation, ecological input, or platform access is brought inside the analytical frame.

Boundary dependence matters especially where GRE studies generativity. An intervention can appear generative inside a beneficiary organization while displacing costs into households or suppliers outside the organizational boundary. A market can appear competitive within a product boundary while depending on an upstream bottleneck excluded from that definition. A local institution can appear resilient when the analysis omits external fiscal or infrastructural support that enables the observed stability. None of these examples makes the narrower boundary illegitimate. They make the reach of the conclusion conditional on it.

Definition 24.84 (Relational boundary-sensitivity profile). A *relational boundary-sensitivity profile* records the target claim, the operative boundary rule, materially plausible alternative boundaries, relations or conditions added or removed under those alternatives, and the aspects of the relational conclusion that remain stable, weaken, reverse, or become indeterminate when the boundary changes.

The profile separates a robust local result from a robust system-level result. If a claim survives several substantively plausible boundaries, confidence in its portability can increase. If it changes, the change is not merely a defect. It can identify the interface through which the supposedly external environment participates in constituting the focal process.

A second boundary problem concerns institutionalized boundaries. Legal incor-

poration, administrative eligibility, statistical categories, organizational membership, property lines, and jurisdictional borders can themselves organize relations. In such cases a boundary is both an analytical choice and an object with relational reality. Sensitivity analysis should not erase that distinction. The question is whether the inquiry is varying an observer-imposed perimeter, describing an enacted boundary, or examining the relation between both.

Proposition 24.85 (Boundary-conditioned relational warrant). *A GRE relational claim whose interpretation or explanatory force changes materially under substantively plausible boundary specifications should be stated as boundary-conditioned unless independent evidence justifies privileging one boundary for the target claim.*

Proposition 24.85 prevents local tractability from being mistaken for natural closure. It also provides a constructive research strategy: cases of high boundary sensitivity identify where further inquiry into external or interface relations is most likely to alter the explanation.

24.5.2 Scale Dependence

Scale creates a related but distinct limitation. Boundary asks what is included; scale asks at what level of organization relational differences are represented. A household relation can be described at the level of individuals, roles, household units, kinship networks, neighborhoods, or intergenerational transfer systems. A firm can be represented through persons, teams, divisions, legal entities, supply networks, sectors, or wider infrastructures. The relation identified at one scale need not preserve its meaning, direction, or explanatory role after aggregation or disaggregation.

Scale dependence can arise through several mechanisms. Aggregation can erase heterogeneity among lower-level relations. Disaggregation can dissolve an emergent relation that exists only among collective units. A local asymmetry can cancel at a higher level, while individually weak relations can aggregate into a strong institutional constraint. Cross-scale feedback can make a relation simultaneously an effect at one scale and a condition at another. GRE therefore should not presume that a relational property travels vertically without transformation.

Definition 24.86 (Relational scale profile). *A relational scale profile records the units and relation types represented at each analytically relevant scale, the aggregation or disaggregation rule connecting those scales, cross-scale couplings, and the relational properties that are preserved, transformed, newly generated, or lost under movement between them.*

The profile makes explicit that scale is not merely a matter of spatial size. Organizational, temporal, institutional, network, and value scales can differ. A relation persistent at a weekly observational scale can disappear at a daily scale and change meaning at a generational one. A formal rule can operate nationally while its enactment is locally heterogeneous. A platform can be centralized technically while economic dependence is distributed unevenly across users and sectors.

Definition 24.87 (Scale-induced relational reclassification). *Scale-induced relational reclassification occurs when a relation legitimately identified at one scale must be assigned a different type, direction, strength, or explanatory role at another scale because the units, aggregation rule, or cross-scale organization changes the property being represented.*

Reclassification is not necessarily inconsistency. It can be a substantive property of multiscale organization. The limitation arises when a claim at one scale is generalized to another without reconstructing the bridge. The multiscale analyses developed elsewhere in this book therefore require explicit scale semantics rather than merely multiple resolutions of the same variable.

Proposition 24.88 (Cross-scale transport condition). *A relational conclusion should be transported across scales only when the inquiry specifies how the relevant relata, relation semantics, and explanatory role are preserved or transformed by the scale transition at the resolution required by the claim.*

This condition permits both invariance and transformation. Some relations may remain substantively stable across scales; others may acquire new meaning. The burden is to identify which case applies rather than assuming either universal scale invariance or universal scale relativity.

24.5.3 Relation Identification

A relational framework can become deceptively precise when the existence of an observed connection is treated as sufficient identification of the relation itself. Transactions, communications, co-presence, legal ties, citations, shared membership, physical proximity, data flows, or repeated interactions are observable structures, but each can support several relational interpretations. Repeated communication need not establish trust; ownership need not establish effective control; co-membership need not establish cooperation; price correlation need not establish direct dependence; a formal contract need not exhaust the enacted employment relation.

Relation identification therefore requires more than endpoints. The inquiry should specify what the relation means in the domain, whether it is directed or symmetric, binary or graded, episodic or continuous, formal or informal, exclusive or multiplex, observed or inferred, and which evidence would distinguish it from nearby relation types. Where these dimensions remain unresolved, a relational graph or formal object can encode more semantic certainty than the evidence supports.

Definition 24.89 (Relation-identification dossier). *A relation-identification dossier records the candidate relation type, relata and their identity criteria, direction and multiplicity where relevant, domain semantics, temporal support, institutional status, observable traces, inferential bridge from trace to relation, plausible rival relation types, and the evidence capable of discriminating among them.*

The dossier is especially important for relations that carry strong explanatory or normative implications. Dependence, authority, domination, trust, obligation, exploitation, care, recognition, and power should not be inferred merely from structural proximity or repeated interaction. GRE can use structural patterns as evidence, but the semantic bridge must be independently justified.

A related problem is multiplexity. The same pair of relata can simultaneously be connected through employment, kinship, debt, friendship, legal authority, information exchange, or shared institutional membership. Compressing these into a single edge can obscure which relation generates the observed effect and how different relation types reinforce or counteract one another.

Definition 24.90 (Relational semantic ambiguity). *Relational semantic ambiguity is the condition in which the available evidence supports the existence of interaction or*

connection while remaining compatible with materially different interpretations of the relation's type, meaning, mechanism, or normative significance.

Ambiguity should be represented rather than hidden. An analysis can remain useful at a coarser level by claiming recurrent interaction, formal linkage, or information exchange while leaving stronger interpretations unresolved.

Proposition 24.91 (Minimum relation-identification condition). *A GRE claim that depends on a specific relation type should identify evidence for the properties that distinguish that type from serious alternatives; where such discrimination is unavailable, the claim should remain at the coarser relational level actually supported by the evidence.*

The proposition parallels the restraint on reverse inference in Section 24.4. The present issue, however, is not only that manifestations are non-invertible. It is that the analytical category "relation" can itself be underspecified unless its semantics are reconstructed.

24.5.4 Relation Persistence

Relational explanation frequently extends across time. GRE speaks of persistent dependence, institutionalized cooperation, enduring power, long-lived exchange relations, intergenerational transfer, stabilized fields, and historical trajectories. These claims require a criterion for deciding when a relation remains the same relation through change and when a new relation has formed.

Persistence is not simple repetition. An employment relation can continue after a change of supervisor, task, wage, or location. A diplomatic relation can persist through changing governments. A credit relation can be renegotiated while preserving an underlying obligation. Conversely, repeated transactions between the same parties can constitute a sequence of separate encounters rather than one continuing relation. Identity over time therefore depends on which relational properties are treated as continuity-bearing for the target inquiry.

Definition 24.92 (Relational persistence profile). *A relational persistence profile records the relation's proposed continuity-bearing properties, changes in relation, rules, roles, intensity, medium, meaning, and causal function, periods of interruption or dormancy, and the evidence used to classify observed variation as persistence, transformation, dissolution, or replacement.*

The profile prevents historical narratives from creating continuity by vocabulary alone. The same label can cover materially different relations across periods, while a relation whose label changes can preserve important structural continuity. This is especially significant where institutional succession, legal reform, technological mediation, or organizational restructuring changes the observable form of an underlying relation.

Definition 24.93 (Relational identity threshold). *A relational identity threshold is the stated set of continuity-bearing properties sufficient for treating temporally separated manifestations as stages of one relation for a specified analytical purpose, together with the changes that would instead require classification as a new relation.*

The threshold is purpose-relative but not arbitrary. A legal inquiry may privilege continuity of authorized rights and obligations; an economic inquiry may privilege continuity of dependency or exchange; a social inquiry may privilege continuity of role or recognition. When a GRE claim depends on several of these dimensions simul-

taneously, one continuity criterion may be insufficient.

Proposition 24.94 (Persistence-sensitive attribution). *A temporally extended GRE attribution should not treat relational continuity as given when changes in the relation's continuity-bearing properties are themselves capable of altering the mechanism or outcome being explained.*

This condition matters for generative analysis because transformation of the relation may be the generative event. Treating the pre- and post-transformation relation as identical can erase precisely the historical change that needs explanation.

24.5.5 Higher-Order Complexity

Pairwise relations are often analytically useful, but many economic processes depend on configurations whose relevant unit is a group, a relation among relations, a rule governing other relations, or a nested and multilayer arrangement. Chapter 5 developed higher-order relational knowledge, and Chapters 7–8 introduced corresponding methodological and formal resources. The limitation is that higher-order enrichment can expand faster than the available evidence and faster than the capacity of a model to discriminate among competing configurations.

A three-party guarantee, a multilateral bargaining arrangement, a household allocation rule, a supply-chain standard, or a governance meta-rule can possess properties not preserved by decomposing it into independent dyads. Conversely, representing every possible higher-order combination can create an enormous space of candidate structures with little evidential basis. The challenge is therefore not to maximize relational order but to preserve the lowest order that still retains the target-relevant structure.

Definition 24.95 (Higher-order reconstruction burden). *The higher-order reconstruction burden is the additional evidential and semantic warrant required when a GRE claim attributes explanatory significance to collective relations, relations among relations, nested relations, multilayer configurations, hyperrelations, or other structures not recoverable from the independently interpreted pairwise relations alone.*

This burden includes evidence that the higher-order object exists as more than an analyst's convenient grouping, that its membership or components are identified, that its higher-order property matters to the target claim, and that a simpler lower-order representation would lose substantively relevant information.

Definition 24.96 (Relational projection loss). *Relational projection loss is the target-relevant information lost when a higher-order or multilayer relational configuration is represented at a lower order, fewer layers, or a coarser relational type.*

Projection loss can be diagnosed empirically or conceptually. If a pairwise projection predicts or explains the target as well as the higher-order model, the additional structure may not be needed for that claim. If the projection destroys collective eligibility rules, joint obligations, coalition constraints, or relational dependencies among ties, higher-order representation has earned its place.

Proposition 24.97 (Minimum sufficient relational order). *GRE should represent relational order no higher than required to preserve the target-relevant structure and no lower than permitted by the evidence and mechanism, with departures in either direction treated as potential sources of explanatory distortion.*

The proposition guards against two symmetric errors: dyadic reduction of gen-

uinely collective structure and formal inflation through unnecessary higher-order objects. Complexity is not evidence of adequacy; adequacy depends on preserving the structure relevant to the research question.

24.5.6 Field Reconstruction

Field language extends relational analysis from identifiable local ties to distributed conditions in which position within a wider organization changes capacities, constraints, expectations, or the meaning of local relations. This can be indispensable when no single dyad carries the explanatory burden. It also creates a distinctive limit: “field” can become a residual term for whatever appears systemic but has not been reconstructed.

A defensible field claim requires more than a patterned outcome. Similar regularities can arise from common exposure, selection, shared institutions, synchronized response, network diffusion, correlated constraints, or genuinely distributed relational conditioning. A field explanation should therefore identify what structure is distributed, how positions differ, what evidence supports the reconstructed organization, which boundary and scale apply, and what rival mechanisms could generate similar manifestations.

Definition 24.98 (Field-reconstruction adequacy profile). A *field-reconstruction adequacy profile* records the target phenomenon, proposed distributed organization, positional or dependency structure, boundary, scale, temporal interval, local and cross-field relations, evidence for distributed conditioning, serious rival mechanisms, and the conclusions that remain stable across plausible field specifications.

The profile also preserves ontological restraint. A successful field representation can establish that a distributed relational organization is explanatorily useful and evidentially supported without establishing that reality is fundamentally field-like. Section 24.2 already separates explanatory priority from ontological priority; field reconstruction is one concrete application of that distinction.

A second problem concerns overlapping fields. Financial, legal, professional, technological, political, educational, and cultural organizations can condition the same actor simultaneously. A result attributed to one field may depend on a cross-field conversion or coupling. GRE should therefore resist attributing residual variation to the most visible field when a multi-field explanation remains plausible.

Definition 24.99 (Field-attribution remainder). A *field-attribution remainder* is the part of a target pattern left insufficiently explained after the proposed field’s distributed organization, local relations, boundary, scale, and plausible overlapping fields have been reconstructed at the resolution warranted by the evidence.

The remainder should not automatically be absorbed into a more expansive field. It can indicate omitted local mechanisms, another field, measurement or manifestation problems, stochastic variation, material constraints, or a mistaken target specification.

Proposition 24.100 (Field non-residuality condition). A *relational-field explanation* should add discriminating structure beyond the statement that outcomes are context-dependent or systemically organized; where no such structure is identified, field language should be treated as a heuristic rather than as a completed explanation.

24.5.7 Missingness

Relational missingness differs from ordinary missing values because one unobserved relation can alter the apparent positions, paths, clusters, dependencies, brokerage relations, higher-order configurations, and field boundaries of many observed elements. Chapter 7 developed missingness in relational data as a methodological problem. At the level of theoretical limitation, the key issue is that relational structure can be highly sensitive to evidence that is absent precisely because the relation is informal, concealed, unequal in observability, excluded by institutional recording, or generated outside the research boundary.

Missingness therefore has both a data dimension and a structural dimension. An unseen edge may be inconsequential for one claim and decisive for another. Missing a peripheral acquaintance may not change a target network substantially; missing the relation through which funding, authority, coercion, or coordination travels can reorganize the interpretation of the whole configuration.

Definition 24.101 (Relational missingness sensitivity envelope). *A relational missingness sensitivity envelope is the range of substantively plausible unobserved relations or higher-order configurations under which a specified relational conclusion remains stable, changes in degree, changes in type, or becomes unsupported.*

The envelope is necessarily claim-relative. A conclusion about whether two observed actors communicated can remain robust even when much of the wider network is missing. A conclusion about centrality, gatekeeping, dependence, or field position can be far more sensitive to unseen ties. Reporting a single estimated structure without this distinction can create false confidence.

Missingness can also be patterned by the system itself. Powerful actors may communicate through less observable channels; informal care and household labor may remain outside administrative records; precarious actors may leave fewer durable traces; platform architectures can make some interactions visible while hiding others; archives can preserve institutional voices unevenly. In such cases missingness is not only an obstacle to reconstructing relational reality. The pattern of missingness can itself be a manifestation of inequality, strategic concealment, institutional legibility, or power.

Definition 24.102 (Structurally informative relational missingness). *Structurally informative relational missingness is patterned non-observation for which there is independent reason to treat the probability, form, or location of missing relations as partly generated by the relational organization being studied.*

The phrase “independent reason” is important. Researchers should not infer a hidden power relation merely because data are absent. Evidence about the observation process, incentives, institutional recording rules, concealment mechanisms, or comparison cases is needed before missingness becomes substantive evidence.

Proposition 24.103 (Missingness-sensitive relational claim). *A GRE claim about relational position, configuration, higher-order organization, or field structure should report sensitivity to plausible unseen relations whenever such relations could materially change the target property, while distinguishing uncertainty caused by missingness from evidence that the missingness mechanism is itself relationally generated.*

24.5.8 Limits of Relational Reduction

The preceding subsections identify specification limits within relational analysis. A more general danger arises when relational language becomes so inclusive that it absorbs every competing explanation. If material properties, internal organization, biological constraints, technical mechanisms, phenomenological qualities, legal validity, symbolic content, or domain-specific processes are always redescribed as “relations,” relational analysis loses the ability to say what would count as evidence for a genuinely different explanatory structure.

This issue is related to but distinct from the ontological limit discussed in Section 24.2. The ontological question asks whether reality may contain objects or properties not exhausted by relational constitution. The present question is methodological and explanatory: even if some object is relationally constituted in a broad metaphysical sense, is a relational description sufficient to explain the target mechanism at the required resolution? A semiconductor can depend on relational organization while still requiring physical properties for a technical explanation. A legal relation can be socially generated while legal validity depends on domain-specific rules not recoverable from a generic network description. An experience can be socially conditioned while its phenomenological character remains analytically significant.

Definition 24.104 (Relational reduction). *Relational reduction* is an explanatory strategy that treats target-relevant properties, mechanisms, or constraints as adequately accounted for by relations or relational configurations while omitting non-relationally represented or domain-specific components that make an independent material difference to the claim.

Relational reduction is not identical to relational explanation. A strong relational explanation can show that a position, connection, dependency, rule, or distributed structure makes a substantial difference while leaving room for internal, material, technical, legal, ecological, psychological, or other components. The question is whether those omitted components alter the explanation rather than whether they can be redescribed relationally at some sufficiently abstract level.

Definition 24.105 (Mixed explanatory architecture). A *mixed explanatory architecture* combines relational mechanisms with independently specified entity-level, material, technical, institutional, phenomenological, normative, or other domain-specific components when the target claim depends materially on more than relational organization alone.

Mixed explanation is not a retreat from GRE. It can increase relational precision by preventing relations from carrying explanatory burdens they do not need to bear. GRE’s distinctive contribution can concern how the components are connected, transformed, allocated, or made generative without claiming that every component is exhaustively relational at the operative analytical level.

Proposition 24.106 (Bounded relational explanation). *A relational explanation can be strong without being exhaustive: GRE should claim relational sufficiency only when plausible independently specified components fail to add target-relevant explanatory discrimination at the boundary, scale, temporal horizon, and resolution of the inquiry.*

This proposition provides a practical test against conceptual inflation. If every rival mechanism can be absorbed into an ever broader notion of relation, the framework becomes difficult to challenge. By contrast, bounded relational explanation asks what

additional evidence or mechanism would change the result and permits another explanatory vocabulary to carry that part of the account when warranted.

Definition 24.107 (Relational-explanation revision trigger). A *relational-explanation revision trigger* is evidence that a GRE relational conclusion changes materially under a substantively warranted alternative boundary, scale, relation identification, continuity criterion, higher-order specification, field reconstruction, missingness scenario, or independently specified non-relational or domain-specific mechanism.

Revision need not imply abandonment. The response can be narrower scope, a different scale, a retyped relation, a discontinuity in the historical trajectory, a higher- or lower-order representation, a revised field boundary, an uncertainty interval over missing structure, or a mixed explanatory architecture. More substantial revision is required when relational formulations repeatedly fail to discriminate among rival explanations or when non-relationally represented mechanisms systematically outperform them for the programme's central targets.

Relational limits therefore do not undermine the relational orientation of GRE. They specify the conditions under which that orientation remains informative. Boundaries can be permeable without becoming irrelevant; scales can transform relations without making comparison impossible; relation types can be uncertain without collapsing into arbitrary labels; persistence can be historical without being assumed; higher-order structures can be represented without maximizing formal complexity; fields can capture distributed conditioning without becoming residual metaphors; missingness can be analyzed without turning absence into speculation; and relational explanation can remain powerful without claiming exhaustiveness. The resulting discipline is one of *bounded relationality*: relations remain central analytical objects, but their identification, organization, and explanatory reach are continually tested against alternative specifications and mechanisms. The next section extends this critical discipline through time by examining historical reconstruction, missing archives, retrospective bias, changing categories, multiple timescales, fast-slow assumptions, criticality hypotheses, non-teleology, and the limits of historical generalization.

24.6 Historical Limits

The preceding sections examined limits arising from ontology, epistemic access, manifestation and representation, and relational specification. Historical inquiry concentrates these difficulties because its objects are temporally displaced, its traces are selectively produced and preserved, its categories change, and its explanatory mechanisms can operate across several timescales at once. The role of this section is therefore to specify the limits internal to historically informed GRE rather than to restate that economic structures have histories. Its objective is to distinguish what can be reconstructed from surviving evidence, what remains historically underdetermined, how later knowledge can distort earlier possibility structures, when temporal decompositions are warranted, and what evidential burden should accompany fast-slow, criticality, and cross-period generalizations. The discussion proceeds through historical reconstruction, missing archives, retrospective bias, changing categories, multiple timescales, fast-slow assumptions, criticality hypotheses, non-teleology, and the limits of historical generalization. The method is reconstructive and comparative: his-

Table 24.6: Historical limits and corresponding GRE disciplines

Historical limit	Risk to inference	Required GRE discipline
Reconstruction	One surviving chronology is treated as the uniquely warranted generative history	Preserve rival histories compatible with the evidence and distinguish chronology from mechanism
Missing archives	Surviving traces are mistaken for an unbiased sample of past relations	Reconstruct record production, preservation, access, and detection conditions
Retrospective bias	Known outcomes reorganize earlier possibilities into an apparently inevitable path	Reconstruct contemporaneous information, constraints, and feasible alternatives
Changing categories	Stable labels are treated as stable historical objects	Trace category genealogy, semantic drift, institutional use, and comparison bridges
Multiple timescales	One temporal resolution is imposed on processes operating at different rates	Specify process-relative clocks and test cross-scale conclusions for temporal aliasing
Fast-slow assumptions	Rate separation is presumed rather than historically demonstrated	Treat fast-slow structure as regime-dependent and test for coupling, inversion, and changing rates
Criticality hypotheses	Volatility, transition, or sensitivity is labeled “critical” without discriminating evidence	State the criticality claim type, expected signatures, rival mechanisms, and failure conditions
Teleology	Later stabilization or value is read backward as historical direction or purpose	Preserve branch structure, contingency, failed alternatives, and non-progressive generation
Historical generalization	A mechanism found in one period is transported to another without warrant	Specify invariants, changed conditions, domain of transport, and period-specific remainder

torical claims are treated as warrant-bearing interpretations whose evidential pathways, category bridges, temporal resolutions, and transport conditions should remain inspectable.

Chapter 23 established that economic claims depending materially on inherited institutions, sequence, changing categories, or temporal coupling should remain answerable to historical reconstruction. The present section adds a complementary restraint: historical reconstruction itself is limited. A historically situated GRE should therefore avoid two symmetrical errors. The first is presentism, in which current categories and outcomes are projected backward as though they organized the past in the same way. The second is historical insulation, in which invocation of contingency makes historical claims too elastic to be corrected. Historical humility is strongest when the reconstruction specifies both what the evidence supports and what would require reinterpretation.

Definition 24.108 (Historical limitation profile). A *historical limitation profile* records, for a specified GRE claim, the temporal interval and resolution, surviving evidence, archive and record-production conditions, category changes, contemporaneous possibility structure, relevant timescales, proposed historical mechanism, rival reconstructions, and conditions under which the claim should be narrowed, retyped, or revised.

Table 24.6 summarizes the principal historical limitations developed below and the corresponding discipline required of GRE.

24.6.1 Historical Reconstruction

Historical reconstruction in GRE is an inverse problem with a temporal asymmetry. The researcher observes surviving traces in the present and attempts to infer earlier relational configurations, sequences, constraints, and generative mechanisms. Chapter 7 developed relational reconstruction as a methodological task, while Section 24.3 showed why inverse problems need not yield a unique antecedent configuration. His-

torical reconstruction adds a further difficulty: the observation process itself changes through time. Institutions create records unevenly, categories are revised, actors alter practices, archives are reorganized, and later events affect which earlier traces become salient enough to preserve or retrieve.

A chronology can therefore be well established while the mechanism generating it remains uncertain. Knowing that a statute preceded an organizational change does not establish that the statute caused the change. Knowing that a price transition, political crisis, technological release, or institutional merger occurred at a particular date does not determine which relational mechanisms made the transition possible. Conversely, incomplete chronology need not preclude every historical claim if some higher-level property is stable across the serious orderings compatible with the evidence.

Definition 24.109 (Historical reconstruction envelope). *A historical reconstruction envelope is the set of serious historical configurations, event orderings, relation structures, and generative mechanisms that remain compatible with the surviving evidence, explicit source assumptions, temporal resolution, and currently warranted category interpretation relevant to a specified claim.*

The envelope is claim-relative. A reconstruction may be too indeterminate to establish who initiated a particular informal agreement while still supporting a strong conclusion that a new coordination relation existed before the formal institution that later recorded it. Similarly, disagreement about the exact onset of an institutional transition can coexist with agreement that the transition occurred within a bounded interval and altered later feasible paths.

Historical narrative itself can compress the reconstruction envelope. Narrative requires selection, sequence, and emphasis. These operations are indispensable, but they can create an appearance of continuity or causal direction stronger than the underlying evidence warrants. Historical analysis should therefore distinguish narrative coherence from evidential uniqueness. Abbott's emphasis on temporality and sequence and Sewell's analysis of transformative events both caution against treating social processes as temporally homogeneous or reducible to static covariates Abbott 2001; Sewell 1996.

Proposition 24.110 (Reconstruction-specific historical warrant). *A historically grounded GRE claim should be no more specific about sequence, relation, mechanism, or agency than the corresponding historical reconstruction envelope permits, unless additional evidence discriminates among the remaining serious reconstructions.*

This proposition does not require historical agnosticism. It requires matching inferential granularity to historical warrant. Strong conclusions can survive incomplete reconstruction when they concern properties shared across the serious histories. Weakly supported details should remain weakly supported even when they make a narrative more elegant.

24.6.2 Missing Archives

Historical evidence is not produced by a neutral recording device. Records arise within organizations, states, households, firms, courts, movements, platforms, communities, and administrative systems that differ in what they record, whose actions count as recordable, how long records survive, and who can later access them. Archival scholarship has repeatedly emphasized that archives participate in the pro-

duction of historical memory rather than functioning merely as passive containers Schwartz and Cook 2002; Stoler 2009. Trouillot likewise shows how silences can enter at several stages of historical production, from fact creation to archival assembly and retrospective significance Trouillot 1995.

For GRE, archival incompleteness is especially consequential because missing records can distort relational structure. Formal contracts may survive while informal care, trust, coercion, negotiation, and household labor leave sparse traces. Large institutions can preserve correspondence, minutes, accounts, and legal files while precarious organizations or marginalized actors leave fragmented records. A later researcher can therefore observe a dense documentary network around actors who were record-rich and a sparse network around actors who were historically important but weakly archived.

Definition 24.111 (Historical observability profile). *A historical observability profile* records which historically relevant actors, relations, events, categories, and material processes were likely to generate traces; the institutions controlling record production and retention; known destruction, dispersal, secrecy, or access restrictions; cataloguing and retrieval conditions; and the expected consequences of these processes for the reconstruction at issue.

A missing document is not yet evidence that the underlying event or relation was absent. The evidential value of non-observation depends on detection conditions. If a transaction would almost certainly have generated a surviving standardized record, its absence can matter. If the relevant relation was informal, secret, poorly archived, or outside the institution's recording ontology, non-observation carries much less weight.

Definition 24.112 (Archival absence warrant). *An archival absence warrant* is the independently supported basis for inferring that non-observation of a historical trace provides evidence against the occurrence of a specified event, relation, or institutional act because the relevant record-production, preservation, access, and retrieval conditions would ordinarily have made the trace observable.

This distinction prevents two opposing mistakes. One is evidential positivism: only what survives in the archive is treated as historically real. The other is speculative compensation: any missing relation can be asserted because the archive is incomplete. The historical observability profile and archival absence warrant constrain both moves.

Missingness can also be substantively generated. Secrecy, exclusion, informal organization, unequal literacy, discriminatory administrative categories, strategic destruction, and power over record systems can affect what survives. Yet, as Section 24.5 argued for relational missingness generally, absence becomes evidence of such a mechanism only when the observation process is independently reconstructed. Historical silence can motivate inquiry; it cannot by itself prove the relation proposed to explain the silence.

Proposition 24.113 (Archive-conditioned historical claim). *When the evidential support for a GRE historical claim depends materially on records whose production, preservation, access, or retrieval is systematically unequal, the claim should incorporate that archival selection process into its uncertainty or mechanism analysis rather than treating surviving traces as an unconditioned sample of the past.*

24.6.3 Retrospective Bias

Historical actors did not know the future that the researcher knows. Once an outcome is known, earlier events can be reorganized into a sequence that appears to point toward it. Signals that mattered only in retrospect become highlighted; failed alternatives disappear; actors who later became central seem important from the beginning; and contingent turning points are redescribed as stages in an emerging order. Retrospective knowledge can therefore alter not only interpretation of the past but the reconstructed topology of earlier possibility.

This problem is not solved by refusing hindsight altogether. Later evidence can reveal structures that contemporaries could not observe, and retrospective comparison can identify consequences that only became visible over longer horizons. The task is to distinguish legitimate retrospective knowledge from illegitimate projection of later categories, outcomes, and significance backward into the earlier decision environment.

Definition 24.114 (Contemporaneous possibility profile). A *contemporaneous possibility profile* reconstructs, for a specified historical position, the information plausibly available at the time, recognized categories, institutional and material constraints, feasible alternatives, anticipated consequences, relevant uncertainties, and relations through which actors could perceive or act on those possibilities.

The profile is not a claim that actors perceived every objectively available alternative. It separates at least three sets: alternatives later imaginable to the historian, alternatives structurally accessible in the historical configuration, and alternatives recognized or actionable from the position of particular actors. Conflating these sets can make past decisions appear irrational, inevitable, or morally obvious in ways that depend on later knowledge.

Path dependence provides an important example. Pierson's work on increasing returns illustrates how sequences can make later reversal progressively costly Pierson 2000. But path dependence should not be inferred merely because a path persisted. Persistence observed after the fact does not establish that early alternatives were equivalent, that increasing returns operated, or that a small initial contingency determined the outcome. A mechanism must connect sequence to changing later accessibility.

Definition 24.115 (Outcome-knowledge contamination). *Outcome-knowledge contamination* occurs when knowledge of a later historical outcome changes the inferred significance, probability, feasibility, agency, or category of earlier events beyond what is warranted by contemporaneous structure and surviving evidence.

Proposition 24.116 (Retrospective-separation requirement). A *GRE historical explanation* should distinguish what is warranted retrospectively about the realized trajectory from what was knowable, feasible, or salient within the earlier historical configuration whenever the distinction materially affects claims about agency, contingency, responsibility, or path dependence.

This requirement also protects normative analysis. Historical actors can remain responsible for evidence, harms, or alternatives available to them without being judged as though they possessed later knowledge. Conversely, the fact that actors lacked later knowledge does not immunize choices when contemporaneous evidence already supported criticism.

24.6.4 Changing Categories

Historical comparison requires categories, but categories themselves have histories. Terms such as “worker,” “household,” “firm,” “property,” “unemployment,” “credit,” “citizen,” “skill,” “care,” “platform,” or “artificial intelligence” can change in legal definition, statistical construction, institutional use, social meaning, and practical consequence. A stable word can therefore refer to different relational objects across periods, while different words can organize partially continuous practices.

Classification systems are also active institutions. Bowker and Star show how classifications organize social and technical worlds rather than simply reflecting them Bowker and Star 1999. Section 24.4 developed this point for representation generally. Historical analysis adds semantic drift and institutional succession: a category can change while records preserve the same column heading, or the category can remain formally stable while the practices it governs change substantially.

Definition 24.117 (Historical category genealogy). A *historical category genealogy* reconstructs the emergence, definitions, institutional carriers, inclusion and exclusion rules, practical uses, contested meanings, and transformations of a category across the historical interval relevant to a GRE comparison.

A genealogy makes comparison harder but more defensible. It can reveal that two periods are directly comparable for one purpose but not another. A historical wage series, for example, may remain useful for a price-adjusted income question even if employment categories changed, while a claim about occupational status or labor-market participation may require a more substantial bridge.

Definition 24.118 (Historical category bridge). A *historical category bridge* specifies the dimensions on which two temporally separated categories or category instances are treated as comparable, the transformations required to construct that comparison, the dimensions intentionally left non-equivalent, and the evidence supporting the bridge.

The bridge should preserve translation loss. It should not silently harmonize away the historically meaningful difference that the inquiry is trying to understand. Koselleck’s work on historical semantics is especially relevant to the problem that concepts carry temporal structures and changing horizons of expectation Koselleck 2004.

Proposition 24.119 (Category-continuity restraint). *Continuity of a historical label should not be treated as continuity of the represented economic or relational object, and discontinuity of labels should not be treated as discontinuity of the object, without an explicit category genealogy and claim-specific comparison bridge.*

This restraint matters for long-run datasets as much as for qualitative narrative. Harmonization can be analytically useful, but every harmonized series is a representation produced by rules. Where the rules erase a historically consequential change in category, apparent temporal continuity can be manufactured by the researcher.

24.6.5 Multiple Timescales

Economic history rarely unfolds on one clock. Transactions, prices, attention, political decisions, organizational routines, professional formation, infrastructure, demography, legal doctrine, ecological regeneration, and cultural expectations can change at materially different rates. Chapter 23 developed multiscale historical interfaces; the present concern is the limit generated when a researcher imposes one temporal

resolution on processes whose explanatory relations depend on several.

A yearly dataset may be appropriate for one institutional process and too coarse for a financial panic occurring within days. A daily dataset may capture market movements while being too short to identify changes in professional formation or land-use structure. Temporal aggregation can also reverse apparent sequence. Processes that look simultaneous at a decadal scale may have a meaningful order at the monthly or yearly scale, while high-frequency fluctuations can obscure a slower institutional transformation.

Definition 24.120 (Historical timescale profile). A *historical timescale profile* identifies the processes relevant to a historical GRE claim, their substantively warranted temporal resolutions or characteristic durations, the evidence available at those resolutions, and the cross-scale relations through which change at one timescale conditions or is conditioned by change at another.

The profile avoids treating a timescale as an intrinsic property of an entity. A central bank can act within hours during a crisis and evolve institutionally over decades. A household can make an immediate purchase while reproducing wealth relations across generations. What counts as fast or slow is therefore process-relative and regime-dependent.

Definition 24.121 (Temporal aliasing in historical inference). *Temporal aliasing in historical inference* occurs when the temporal resolution of evidence or analysis makes distinct processes, sequences, oscillations, delays, or transitions appear equivalent, simultaneous, reversed, or absent in a way that materially changes the historical conclusion.

Temporal aliasing can affect causal interpretation. If an institutional response is observed only annually, a sequence of rapid intervention, temporary reversal, and later stabilization may appear as a smooth annual change. Conversely, selecting a very fine resolution can exaggerate short-lived fluctuations while concealing the slower constraint that bounds them.

Proposition 24.122 (Multiscale historical adequacy). *A historical GRE claim involving mechanisms that plausibly operate at materially different temporal resolutions should identify the relevant timescales and test whether the conclusion is stable under alternative defensible temporal aggregations or requires an explicitly coupled multiscale account.*

24.6.6 Fast–Slow Assumptions

Fast–slow language is useful when some processes change sufficiently rapidly relative to others that partial separation clarifies the mechanism. It becomes misleading when “fast” and “slow” are treated as permanent types of variable or institution. Rates can change historically. A legal process that is usually slow can become rapid during emergency legislation. A technological standard can remain stable for years and then change quickly. A market that usually adjusts rapidly can freeze. Educational or demographic processes can interact with sudden policy shocks in ways that invalidate ordinary rate separation.

The historical question is therefore not whether one variable can be named fast and another slow, but whether a relevant interval exhibits sufficient rate separation for the intended inference. The answer depends on process definition, temporal res-

olution, coupling strength, and regime.

Definition 24.123 (Historical rate-separation profile). A *historical rate-separation profile* records the processes compared, the interval and regime in which their rates are estimated or interpreted, evidence for the relative rate difference, coupling between the processes, known transitions in characteristic rates, and the inference that depends on treating the processes as comparatively fast or slow.

A strong separation in one regime can disappear in another. This motivates attention to *fast-slow inversion*: a process ordinarily treated as background can become the rapidly changing driver, while a process ordinarily treated as responsive can become constrained or frozen. Historical episodes involving war, crisis, technological discontinuity, constitutional change, ecological shock, or rapid institutional mobilization can produce such inversions.

Definition 24.124 (Fast-slow regime failure). A *fast-slow regime failure* occurs when the rate separation, weak coupling, or quasi-stationarity required for a fast-slow interpretation no longer holds over the historical interval relevant to the claim.

Fast-slow analysis can also import false causal direction. The slower process is not automatically the structural cause and the faster process is not automatically the response. Slow variables can constrain without determining; fast variables can accumulate into structural change; and cross-scale feedback can run in both directions.

Proposition 24.125 (Regime-bounded fast-slow claim). A *GRE fast-slow interpretation* should be stated as a *regime-bounded historical claim* whose validity depends on demonstrated relative rates, coupling, and temporal resolution, and it should be revised when rate separation collapses, reverses, or ceases to support the inferred mechanism.

24.6.7 Criticality Hypotheses

Criticality is potentially valuable to GRE because systems near qualitative transition can display heightened sensitivity, changing correlation structure, large responses to comparatively small perturbations, and reorganization of accessible trajectories. Earlier chapters used criticality cautiously as one possible analytical hypothesis. The historical limit arises when transition, instability, volatility, or retrospective importance is redescribed as criticality without specifying what kind of criticality is proposed and what evidence distinguishes it from alternative mechanisms.

Historical data are particularly vulnerable to post hoc criticality claims. Once a major transition is known, preceding fluctuations can be interpreted as warning signals even when similar fluctuations occurred in periods without transition. Sparse temporal data can make an apparent divergence or slowdown an artifact of measurement resolution. Institutional coordination, external shock, strategic action, threshold rules, contagion, or ordinary nonlinear response can sometimes produce patterns resembling selected signatures associated with critical transitions.

Definition 24.126 (Historical criticality claim profile). A *historical criticality claim profile* identifies the proposed critical phenomenon, system boundary, order or state variables, historical interval, expected signatures, evidence resolution, candidate perturbations, rival transition mechanisms, and observations that would weaken or defeat the criticality interpretation.

The profile should also classify the status of the claim. A criticality metaphor organizes attention to sensitivity near transition. A structural criticality hypothesis pro-

poses specific relational or dynamical features without complete empirical parameterization. An empirically parameterized criticality model carries stronger commitments about observables, scaling, or transition structure. These levels should not be rhetorically merged.

Definition 24.127 (Criticality attribution remainder). *A criticality attribution remainder is the part of an observed historical transition pattern that remains equally or better compatible with serious non-critical mechanisms after the expected criticality signatures and data limitations have been specified.*

A large attribution remainder does not make criticality useless. It changes the epistemic status from explanation toward heuristic or open hypothesis. Historical cases can still motivate formal or comparative research without being treated as completed confirmations.

Proposition 24.128 (Criticality evidential restraint). *A historical GRE account should not infer criticality from transition importance, volatility, sensitivity, or qualitative change alone; the criticality interpretation should add discriminating expectations beyond those phenomena and remain answerable to rival mechanisms and non-transition comparison periods.*

This proposition is especially important for governance. If every crisis is called a critical point after it occurs, criticality cannot guide prospective observation or discriminate among policy environments. A useful criticality hypothesis must expose itself to the possibility that the system was unstable, nonlinear, strategically coordinated, externally shocked, or institutionally transformed without being critical in the relevant formal or structural sense.

24.6.8 Non-Teleology

GRE is generative, but generativity does not imply historical progress. A configuration can generate later capacities, institutions, values, dependencies, exclusions, harms, or possibilities without moving toward a predetermined end. Likewise, survival does not prove superiority, stability does not prove desirability, and increasing complexity does not establish advancement. Historical explanation becomes teleological when later existence, function, or value is treated as the purpose toward which earlier processes were directed without independent evidence for such purposive organization.

Teleology can enter subtly through vocabulary. An institution can be described as “developing toward” its present form; a market as “maturing”; a technology as “inevitably replacing” another; an organization as “learning” a function that later became central. Such language may be warranted when actors explicitly pursued the end and their purposive action explains the path. It is not warranted merely because the end eventually occurred.

Definition 24.129 (Historical teleology diagnostic). *A historical teleology diagnostic asks whether a claimed historical direction depends on independently evidenced actor purposes, selection mechanisms, institutional rules, or dynamical constraints operative during the process, or instead derives primarily from knowledge of the later outcome.*

Non-teleology also requires preserving failed alternatives. Histories written only from surviving institutions can erase experiments, coalitions, technologies, norms, organizations, and policies that were once serious possibilities. Their failure can be

theoretically informative because it reveals constraints, power relations, coordination problems, value conflicts, or contingent events that shaped the realized path.

Definition 24.130 (Historical branch-preservation requirement). The *historical branch-preservation requirement* is the discipline of retaining substantively supported unrealized alternatives in the reconstruction whenever their availability, closure, suppression, or failure materially affects claims about contingency, agency, power, generativity, or inevitability.

Proposition 24.131 (Non-teleological generativity). A GRE claim that one historical configuration generated another should not by itself be interpreted as a claim that the later configuration was intended, historically necessary, normatively superior, or the natural completion of the earlier one.

This proposition protects the concept of generation from becoming a philosophy of progress. Generative analysis asks how later possibilities became accessible or inaccessible. It can therefore examine decline, lock-in, destruction, failed coordination, institutional erosion, or harmful path formation with the same conceptual vocabulary used for capability creation.

24.6.9 Limits of Historical Generalization

Historical explanation seeks more than isolated description, yet historical mechanisms are often conditional on institutions, technologies, categories, material environments, legal orders, cultural meanings, and distributions of power that change across periods. The challenge is therefore to generalize without stripping away precisely the historical conditions that made the mechanism work.

A repeated pattern can support several different conclusions. It may reveal a genuinely portable mechanism; a family resemblance produced by different mechanisms; recurrence created by similar institutional conditions; or a classification imposed by the analyst. Conversely, a mechanism can be genuinely recurrent even when its surface manifestation differs because the categories, technologies, and institutions through which it operates have changed.

Definition 24.132 (Historical transportability profile). A *historical transportability profile* specifies the mechanism or relational structure proposed for transfer across periods, the source and target historical regimes, conditions treated as invariant, conditions known to differ, required category bridges, relevant timescales, expected manifestation changes, and evidence capable of showing that the mechanism has ceased to transport.

Historical transportability is therefore stronger than analogy and weaker than timeless law. It is a conditional claim that a mechanism remains informative across a specified change in historical context. The profile should make the conditionality visible.

Definition 24.133 (Historical generalization remainder). A *historical generalization remainder* is the period-specific structure, meaning, mechanism, or constraint that remains unexplained or distorted when a historical GRE concept or mechanism is transported from one temporal regime to another.

A remainder can indicate that the generalization should be narrowed, decomposed, or abandoned. It can also identify the historically variable interface through which a more stable mechanism is realized. For example, a dependency mechanism may

recur while the legal instruments producing it change; a value-conversion process may recur while the recognized value forms differ; a coordination problem may recur while communication technologies radically alter temporal scale.

Cross-period comparison should also resist selecting cases only because they culminate in the outcome of interest. Historical generalization becomes stronger when non-transition periods, failed cases, differently institutionalized cases, and periods with similar initial conditions but divergent trajectories are included. Such comparisons help separate a mechanism from the retrospective salience of successful or catastrophic outcomes.

Proposition 24.134 (Historically bounded generalization). *A GRE historical generalization should state the historical regimes across which it is claimed to transport, the invariants required for that transport, the category and timescale bridges used in comparison, the period-specific remainder, and the kinds of counterevidence that would restrict or defeat the generalization.*

The historical limits developed in this section do not make history inaccessible to GRE. They make historical claims more explicitly reconstructive. A defensible historical account can be strong while leaving some event orderings unresolved; use archives while modeling their selection; learn retrospectively without importing future knowledge into earlier agency; compare changing categories without pretending semantic identity; coordinate multiple timescales without assuming one universal clock; use fast-slow language without fixing rates permanently; investigate criticality without labeling every transition critical; analyze generation without presuming progress; and generalize across periods without erasing historical specificity.

Definition 24.135 (Historical revision trigger). *A historical revision trigger is new evidence or comparative analysis showing that a GRE historical conclusion depends materially on an unsupported reconstruction, archival selection effect, retrospective projection, invalid category bridge, inappropriate temporal resolution, failed rate-separation assumption, weakly discriminating criticality attribution, teleological inference, or non-transportable historical mechanism.*

Historical revision can therefore take several forms: widening the reconstruction envelope, revising the archive model, restoring an unrealized branch, retyping a historical category, changing temporal resolution, replacing a fast-slow interpretation with a coupled account, downgrading criticality from explanation to heuristic, removing progressive language, or narrowing the period over which a mechanism is claimed to generalize. These are not merely defensive qualifications. They are ways in which historical evidence can actively restructure GRE.

The next section turns from historical reconstruction to formalization itself. It examines the limits of schematic, structural, analogical, and parameterized models; model closure and self-reference; the temptation of formal elegance; empirical warrant; and the conditions under which mathematical structure can or cannot be transferred into an economic-relational explanation.

24.7 Formalization Limits

The preceding sections examined limitations arising from historical reconstruction, relational specification, representation, epistemic access, and ontological commitment. Formalization introduces a different class of limits. A formal system can

sharpen distinctions, expose assumptions, organize possible mechanisms, and make consequences traceable. The same precision can also exceed the precision of the underlying concepts, evidence, or historical reconstruction. The role of this section is therefore to specify when formalization strengthens GRE and when it creates a misleading appearance of determinacy. Its objective is to distinguish schematic, structural, analogical, and empirically parameterized uses of formal language; identify burdens associated with parameters, closure, self-reference, and empirical correspondence; and state limits on mathematical transfer, observation–transformation typing, 2-complex representation, and history-weight or amplitude-like models. The method is type-sensitive and claim-relative: a formal object is evaluated by what analytical work it performs, what semantics and evidence support that work, which assumptions are closed for tractability, and which conclusions remain warranted when the formal representation is changed.

GRE does not require a universal mathematical language. Different questions can call for partial orders, networks, dynamical systems, stochastic models, higher-order structures, fields, operator-like representations, category-theoretic diagrams, 2-complexes, qualitative schemata, or no formalism beyond carefully typed prose. Chapter 8 treated this plurality as methodological rather than hierarchical, while Chapter 15 developed several richer representations for historical-relational structure. The present section adds a stronger limitation principle: formal richness is not cumulative evidence. Adding mathematical structure can increase inferential power only when the added structure corresponds to a justified distinction in the target problem.

Definition 24.136 (Formalization limitation profile). A *formalization limitation profile* records, for a specified GRE formalism, its analytical role, model type, object and operation semantics, closure assumptions, parameter status, empirical or interpretive bridges, excluded relations, sensitivity to alternative representations, known non-identifiabilities, and conditions under which the formal result should be narrowed, retyped, or abandoned.

Table 24.7 summarizes the principal limits developed below.

24.7.1 Schematic Models

A schematic model organizes distinctions and dependencies without claiming that every represented object has been measured or that every represented relation constitutes an empirically established mechanism. Flow diagrams, typed boxes, layered architectures, category maps, causal sketches, state-transition schemata, and compact symbolic summaries can all perform this role. They are especially useful in a developing research programme because they make assumptions visible and permit several empirical implementations to be compared against the same conceptual structure.

The limitation is that graphical or symbolic explicitness can be mistaken for evidential completeness. A diagram that distinguishes value generation, conversion, circulation, capture, return, and regeneration may clarify the vocabulary while leaving the existence, strength, or causal relevance of particular pathways untested. Likewise, a schematic representation of a field, history space, or conversion interface can expose candidate mechanisms without identifying which mechanism operates in a concrete case.

Definition 24.137 (Schematic adequacy profile). A *schematic adequacy profile*

Table 24.7: Formalization limits and corresponding GRE disciplines

Formal limit	Primary risk	Required GRE discipline
Schematic form	Diagrammatic or symbolic organization is mistaken for a tested mechanism	State what the schema clarifies and what it does not establish
Structural form	Internal consistency is mistaken for empirical adequacy	Separate preserved structure from warranted correspondence to the target
Analogy	Imported mathematical properties acquire imported ontology or mechanism	Specify which relations transfer and which semantics remain domain-specific
Parameters	Numerical values appear estimable although the target quantities are weakly identified	Record measurement bridges, identification conditions, uncertainty, and equifinality
Closure	Excluded relations are treated as negligible by construction	State the closure purpose, remainder, and sensitivity to reopened interactions
Self-reference	Model outputs alter the modeled process while the model assumes passive observation	Represent feedback between representation, uptake, and later configuration where material
Formal elegance	Simplicity, symmetry, or tractability is treated as evidence	Evaluate elegance as a design virtue distinct from empirical warrant
Empirical warrant	Symbols have clearer semantics than their observational bridges	Match claim strength to independently supported correspondence
Math transfer	Similar equations or structures are treated as shared mechanisms	Preserve semantic, causal, historical, and ontological remainders
Type confusion	Observation/readout is modeled as if it were itself a state-changing operation	Keep observation and transformation maps distinct even when performatively coupled
2-complex	A 2-complex becomes a universal template	Test whether vertices, edges, faces, labels, and order relations preserve the target-relevant structure
History weights	Numerical support over histories is given probabilistic or physical meaning without warrant	State the weight semantics, normalization, composition, evidence, and interpretive limits explicitly

records the distinctions a schematic model is intended to preserve, the relations it proposes for investigation, the empirical commitments it does and does not make, alternative schemata that remain compatible with the current evidence, and the observations or arguments that would require restructuring the schema.

A useful schematic model therefore has a bounded epistemic role. It should compress a conceptual problem while keeping the transition to stronger claims visible. This is important in GRE because a schema can later be instantiated by qualitative process evidence, network data, historical reconstruction, legal analysis, dynamical simulation, or another method. The schema should not prejudice which empirical route will prove adequate.

Proposition 24.138 (Schematic non-upgrade condition). *The internal coherence or repeated reuse of a GRE schema does not by itself upgrade a proposed relation, mechanism, or process from a conceptual possibility to an empirically warranted claim.*

The proposition matters for cumulative theory building. A concept can become familiar through repeated diagrams and notation long before its empirical status improves. GRE should therefore distinguish stabilization of vocabulary from accumulation of evidence.

24.7.2 Structural Models

Structural models represent typed objects and relations more strongly than schemata. They may specify adjacency, order, composition, dependency, incidence, nesting, admissible transformation, or another formal relation whose internal consequences can be derived. A network model can represent ties and paths; a partially ordered event

model can represent precedence constraints; a category-theoretic diagram can represent typed mappings and compositional requirements; a 2-complex can represent linked vertices, edges, and faces across a historical-relational structure.

The principal limit is correspondence. A structural theorem establishes what follows within the model under stated assumptions. It does not automatically establish that the empirical target has the modeled structure, that the structural relation has the proposed substantive meaning, or that omitted dimensions are irrelevant. Two empirical systems can share one structural representation while differing radically in mechanism, history, normativity, or material constitution.

Definition 24.139 (Structural correspondence profile). A *structural correspondence profile* records the formal objects and relations of a model, the target objects and relations they represent, the evidence or argument supporting each correspondence, structural features intentionally omitted, transformations under which the correspondence is expected to remain valid, and conclusions that depend on stronger correspondence than has been established.

Structural adequacy is therefore claim-relative. A graph representation may be adequate for identifying brokerage while inadequate for distinguishing authority from friendship. A partial order may preserve temporal precedence while discarding duration, intensity, or simultaneous interaction. A categorical diagram may clarify compositional typing while saying little about empirical magnitude. The appropriate question is not whether the model is structurally elegant in the abstract, but whether it preserves the distinctions needed for the particular inference.

Proposition 24.140 (Structural non-equivalence condition). *Formal structural equivalence between two representations does not establish equivalence of mechanism, historical formation, normative status, or ontology unless those further correspondences are independently warranted.*

This condition also limits cross-domain inference. Isomorphic or homomorphic structure can support comparison, but the preserved structure must be identified explicitly before any substantive conclusion is transferred.

24.7.3 Analogical Models

Analogical models import selected mathematical structure from another domain because that structure helps formulate a question in GRE. Terms such as field, attractor, phase transition, criticality, amplitude, topology, symmetry, operator, or spacetime can be analytically productive when the imported structure is specified and the local semantics are reconstructed. The history of science contains many fruitful analogies, but usefulness of an analogy does not erase the difference between source and receiving domains.

The limitation arises when analogy becomes semantic inheritance. A social field need not share the ontology, conservation laws, metric structure, locality conditions, or measurement procedures of a physical field. An attractor-like pattern need not be generated by the same equations as a physical dynamical system. A topology-inspired representation of relational continuity does not establish that the target possesses a mathematically complete topology. An amplitude-like history construction does not inherit quantum-mechanical interpretation merely because complex numbers or compositional sums are used.

Definition 24.141 (Formal analogy dossier). A *formal analogy dossier* records the source formalism, the receiving GRE problem, the specific structure being imported, the properties intentionally preserved, source-domain properties not transferred, reconstructed local semantics, added analytical value, and empirical or conceptual tests that could show the analogy to be misleading.

The dossier makes analogy productive precisely by refusing total identification. An analogy can be valuable when it reveals a previously unnoticed distinction, suggests a counterexample, permits a new decomposition, or generates a testable mechanism. It becomes weak when its main support is terminological resemblance or mathematical sophistication.

Proposition 24.142 (Analogy restraint condition). A *GRE inference based on imported mathematics should depend only on those source-formal properties whose receiving-domain interpretation has been separately defined and defended; untransferred source-domain properties carry no automatic inferential authority.*

This principle keeps mathematical borrowing open while preventing metaphysical or empirical conclusions from entering through notation without argument.

24.7.4 Parameter Identification

A model becomes more empirically demanding when its parameters are intended to correspond to measurable or inferable quantities. Parameters can represent rates, strengths, thresholds, transition propensities, elasticities, decay, coupling, accessibility, history weights, or other target-relevant quantities. Numerical specification can improve comparison and falsifiability, but only if the parameters are identifiable under the available evidence and model structure.

Parameter identification differs from numerical fitting. A fitting procedure can return a value even when several parameter combinations generate observationally indistinguishable behavior. A parameter can also be statistically identifiable while its substantive interpretation remains weak because the measured proxy does not isolate the intended relation. Historical and reflexive systems add further difficulty because the parameter itself can change when institutions, categories, or actor responses change.

Definition 24.143 (Parameter-identification profile). A *parameter-identification profile* records the parameter's substantive meaning, observational or interpretive bridge, estimation or calibration procedure, data requirements, structural assumptions, alternative parameter combinations compatible with the evidence, temporal and domain stability assumptions, uncertainty, and the conclusions sensitive to the parameter's value.

The profile should distinguish several situations. In direct identification, the parameter has a clear empirical referent and sufficient observations. In indirect identification, the parameter is inferred through a model whose other assumptions materially contribute to the estimate. In calibration, the value is chosen to reproduce selected patterns without being uniquely inferred from them. In exploratory specification, the parameter ranges over plausible values to test qualitative behavior. These statuses should not be collapsed into one category of "estimated parameter."

Definition 24.144 (Formal equifinality). *Formal equifinality* occurs when materially different parameter settings, model structures, or mechanism specifications generate

outputs that are insufficiently discriminated by the available evidence relevant to the target claim.

Equifinality is not necessarily fatal. A conclusion can remain robust if it is shared across the serious parameter and model combinations. The limitation concerns claims that depend on selecting one combination without discriminating evidence.

Proposition 24.145 (Identification-proportional parameter claim). *The substantive interpretation assigned to a GRE parameter should be no stronger than the identification of the parameter's empirical referent, model dependence, and serious equifinal alternatives permit.*

This proposition prevents quantitative precision from concealing semantic uncertainty.

24.7.5 Model Closure

Formal analysis requires boundaries. A model chooses which entities, relations, variables, events, mechanisms, and external influences to represent. Some interactions are held fixed, aggregated, treated as exogenous, or excluded entirely. Such closure is not inherently a defect. Without closure, many analytical questions would be impossible to formulate. The limitation arises when a tractability choice is silently converted into a claim about causal irrelevance.

Economic systems are especially difficult to close because the relevant boundaries can cross law, politics, ecology, technology, education, social reproduction, and epistemic infrastructure. Chapter 23 developed these interfaces as reciprocal dependencies rather than residual context. A formal GRE model should therefore preserve an explicit remainder when closure excludes relations capable of altering the model's mechanism or result.

Definition 24.146 (Closure specification). *A closure specification records the analytical boundary of a formal model, endogenous and exogenous objects, fixed or suppressed relations, assumed environmental regularities, reasons for the closure, and the conditions under which excluded interactions are expected to become materially relevant.*

Definition 24.147 (Closure remainder). *A closure remainder is the set of excluded, aggregated, externally fixed, or weakly represented relations whose plausible variation could alter the interpretation, mechanism, or conclusions of the formal model.*

The remainder can be studied through sensitivity analysis, nested models, alternative boundaries, qualitative comparison, or explicit coupling to another domain model. The appropriate method depends on the question. A model of a local conversion interface, for example, need not include the entire political economy if the excluded structures are stable relative to the claim. The same model becomes inadequate if legal reclassification, infrastructure ownership, or ecological constraint changes the feasible conversion process.

Proposition 24.148 (Reopenable closure condition). *A GRE formalization can legitimately close selected relations for analysis when the closure is explicit and the principal conclusion remains inspectable under plausible reopening of interactions that could materially change the modeled mechanism.*

Closure is therefore a research design decision rather than a declaration that the world is closed.

24.7.6 Self-Reference

Some GRE models concern systems in which classifications, forecasts, indicators, recommendations, and models themselves enter the relational field. Sections 24.3 and 24.4 examined observer participation and performative representation. Formalization creates an additional problem: a model may assume a fixed target while publication or institutional use of the model changes the behavior, expectations, rules, or resource allocations that constitute that target.

Self-reference can occur at several levels. Actors may respond strategically to a metric. Institutions may redesign procedures around a model-generated risk score. Researchers may change sampling or classification after seeing preliminary outputs. Policymakers can alter rules on the basis of a forecast, thereby changing the process whose future was forecast. An AI system can generate recommendations that influence the data used for later retraining. In each case, the formal model participates in the later object of inquiry.

Definition 24.149 (Formal self-reference profile). *A formal self-reference profile records how a model, indicator, forecast, classification, or formal output can become known to participants, what uptake pathways are available, which modeled variables or relations can respond to that uptake, relevant delays, and whether subsequent observations remain interpretable under the original model specification.*

Not every model requires endogenous self-reference. A historical model of a closed period may have no causal pathway from present analysis to past events. A laboratory model may successfully isolate feedback. The burden rises when model outputs are institutionalized or public and the target is reflexive.

Proposition 24.150 (Reflexive model-revision condition). *When uptake of a GRE model or its outputs can materially change the relations or decision rules represented by that model, later empirical evaluation should distinguish prediction error from target transformation induced partly by the model's own circulation.*

The proposition preserves both accountability and learning. A forecast need not be judged wrong merely because a response to the forecast prevented the predicted event, but neither should performativity be invoked automatically to protect an inaccurate model.

24.7.7 Formal Elegance

Formal elegance is a genuine intellectual virtue. Parsimony, symmetry, compositional clarity, invariance, tractability, and compact representation can reveal deep relations and make a model easier to inspect. GRE should not reject elegance simply because economic and social systems are complex. The limitation is evidential: elegance is a property of a representation, not direct evidence that the world possesses the represented regularity.

A particularly elegant model can become attractive because it compresses many cases into one architecture. This creates a risk of protecting the architecture by reinterpreting every anomaly as a special case, omitted variable, boundary effect, or hidden relation. At that point, elegance can reduce rather than increase falsifiability. The relevant discipline is therefore to preserve model competition and specify which empirical differences would favor a less elegant but better-supported alternative.

Definition 24.151 (Formal-elegance separation). *Formal-elegance separation is the*

explicit distinction between virtues of a representation, such as simplicity, symmetry, tractability, compositionality, or unification, and evidential warrant for the substantive claims represented by that formal structure.

Elegance can legitimately influence model selection when empirical adequacy is otherwise comparable, or when a simpler model achieves the same explanatory discrimination with fewer assumptions. It should not compensate for missing correspondence, unidentified parameters, or failed predictions.

Proposition 24.152 (Elegance non-compensation condition). *Formal elegance cannot compensate for absent semantic definition, unsupported empirical correspondence, unidentified parameters, or systematic counterevidence relevant to the claim the model is intended to support.*

This condition is especially important for ambitious cross-domain formalisms, where aesthetic appeal can otherwise be mistaken for theoretical maturity.

A minimal semigroup–congruence construction illustrates the same limitation from the opposite direction. A bare carrier, a semigroup action, and an equivalence relation preserved by the action can yield a derived notion of distinctions that a mechanism collapses and a local irreversibility result for those collapsed distinctions. The derivation is mathematically economical, but its substantive content depends on what the carrier represents, which mechanisms are admitted, and especially which distinctions the equivalence relation requires the model to preserve.

Caution 24.153 (Congruence semantics). A congruence-based collapse model does not by itself determine which distinctions are socially, economically, legally, or normatively significant. The selected congruence is an exogenous modeling commitment unless separately derived or warranted, and model-relative irreversibility of collapsed distinctions should not be promoted into a universal claim that social history is algebraically irreversible.

24.7.8 Empirical Warrant

Formalization becomes empirically consequential only through bridge claims connecting formal objects to observations, records, interpretations, or interventions. A symbol can be precisely defined within the model while its relation to an empirical object remains uncertain. Section 24.4 called attention to a symbolic-determinacy gap; the present subsection asks how that gap limits formal conclusions.

Empirical warrant has several layers. The target object must be identified. The manifestation or measurement process must support the represented variable or relation. The formal operation must correspond to a substantively meaningful transformation or comparison. The conclusion must remain stable enough under plausible measurement and model uncertainty. Where these layers differ in strength, the final claim should be limited by the weakest bridge material to the inference.

Definition 24.154 (Formal empirical-bridge profile). *A formal empirical-bridge profile records the target object, formal representation, observations or interpretations supporting the correspondence, measurement and manifestation assumptions, uncertainty, rival representations, and the inferential steps by which a formal result is translated back into an empirical GRE claim.*

A formal result can also have conceptual value without an empirical bridge. An impossibility result under stated assumptions can show that a proposed conceptual

package is internally inconsistent. A toy model can reveal a possible mechanism. A structural counterexample can demonstrate that one inference does not follow logically from another. Such contributions should be described as conceptual or structural rather than empirically validated.

Proposition 24.155 (Empirical-bridge bottleneck). *The empirical strength of a GRE conclusion derived from a formal model cannot exceed the warranted correspondence connecting the model's objects, operations, and assumptions to the target phenomenon relevant to that conclusion.*

This proposition allows sophisticated mathematics and epistemic humility to coexist. A mathematically strong result can remain a conditional result until the bridge is strengthened.

24.7.9 Limits of Mathematical Transfer

GRE draws on mathematical resources developed for many other domains. Transfer is often productive because mathematics abstracts structure from its original application. The same abstraction, however, can conceal assumptions that mattered in the source context: continuity, stationarity, conservation, locality, linearity, differentiability, exchangeability, ergodicity, fixed state spaces, well-defined probability measures, or stable composition laws. A receiving-domain application should not inherit these properties simply because the notation is available.

Mathematical transfer is therefore stronger than analogy only when the relevant structural conditions are reconstructed locally. A stochastic process requires a defensible event or state space and probability semantics. A dynamical system requires a meaningful state representation and transformation rule. A field model requires some distributed quantity or operator whose variation across position is interpretable. Category-theoretic composition requires typed morphisms whose composition represents a meaningful composition in the target problem. A topological construction requires locally justified notions of neighborhood, continuity, or adjacency if those concepts do substantive work.

Definition 24.156 (Mathematical transfer dossier). *A mathematical transfer dossier records the source mathematical structure, receiving GRE objects, preserved axioms or relations, altered or rejected assumptions, local semantic reconstruction, empirical or interpretive bridge, closure conditions, and domain-specific remainder that limits the transferred result.*

The dossier supports modular use. GRE need not validate an entire mathematical theory as a model of the economy in order to use one theorem, representation, or structural distinction. The burden concerns the specific transferred result and the assumptions on which it depends.

Proposition 24.157 (Assumption-local mathematical transfer). *A mathematical result imported into GRE supports only those substantive conclusions for which the result's operative assumptions and semantics have been reconstructed in the receiving problem; unused or unjustified source assumptions should not enter the economic interpretation implicitly.*

This proposition makes mathematical pluralism safer. Different formalisms can coexist because each is evaluated locally rather than being promoted to a universal language of GRE.

24.7.10 Observation–Transformation Type Confusion

The project’s notation guide preserves a strict distinction between observation or readout and state-changing transformation. This distinction is easy to blur in reflexive systems because observation can become performative. A survey result can trigger policy. A classification can change eligibility. A prediction can alter behavior. A scientific interpretation can reorganize a research field. Yet the fact that an observation participates in a later transformation does not make the observation map itself identical to the transformation.

The type distinction matters formally. A readout maps a modeled configuration into a representation space. A transformation maps one modeled configuration into another, or changes the rules governing later configurations. A performative epistemic event can couple these operations: the readout is interpreted, communicated, institutionalized, or acted upon, and that uptake generates a later transformation. Collapsing the two maps erases where interpretation, authority, decision, or institutional mediation enters.

Definition 24.158 (Observation–transformation type profile). An *observation–transformation type profile* records the modeled configuration being observed, representation produced by the readout, interpretive or institutional uptake, state-changing operation if any, actor or mechanism authorizing that operation, temporal ordering, and evidence that the coupled process altered later configurations.

The profile also prevents an opposite error. Treating observation as always passive can miss classification effects and reflexive feedback. The appropriate model therefore preserves the type difference while permitting explicit coupling.

Proposition 24.159 (Typed performativity condition). *A GRE model of performative observation should represent the readout and the state-changing operation as distinct typed components unless there is an independently justified formal reason to identify them, while representing the coupling through which the former contributes to the latter.*

This condition keeps epistemic and causal claims separable even when they interact closely.

24.7.11 Limits of 2-Complex Representation

Chapter 15 used 2-complexes as one representation of history-bearing relational configurations. This choice has important advantages. Vertices can represent events or localized configurations, edges can represent relations or transitions, faces can represent higher-order histories or compatibility relations, and labels can carry typed information. The representation is particularly useful when entities are treated as historically extended substructures rather than point-like actors.

The limitation is representational fit. Not every economically relevant relation naturally belongs on an edge, not every higher-order process is well captured by a face, and not every relevant temporal structure is preserved by one incidence architecture. Continuous processes, overlapping memberships, uncertain boundaries, distributed fields, changing relation types, nonlocal constraints, or many-scale processes can require additional structure or another representation entirely. A 2-complex can also over-discretize processes whose relevant variation is continuous or whose event boundaries are analyst-imposed.

A later distinction sharpens this limitation. Some failures concern *cellular dimen-*

sion: the inquiry needs higher-order incidence, attachment, compositional closure, refinement, or generative genealogy to remain native to the carrier rather than being stored only in labels or auxiliary data. A higher CW-complex can address that class of problem while retaining the established 2-complex as a 2-skeleton. Other failures concern *representation family*: continuity, nonlocality, uncertain ontology, distributed fields, noncellular boundaries, or empirically unidentified event segmentation can remain problematic regardless of how many cell dimensions are added. Increasing dimension is therefore one possible repair, not a general response to representational inadequacy.

Definition 24.160 (2-complex adequacy profile). A *2-complex adequacy profile* records the target historical-relational object, semantics of vertices, edges, faces, labels, and order relations, discretization rule, boundary and scale, information preserved and lost by the representation, alternative representations, and the GRE conclusions that depend specifically on the 2-complex structure.

The profile should also distinguish representational convenience from ontological commitment. A target can be usefully represented by a 2-complex without being claimed to be fundamentally a 2-complex. Section 24.2 already established this ontological restraint; the present limitation concerns analytical adequacy even before ontology is considered.

Definition 24.161 (2-complex projection remainder). The *2-complex projection remainder* is the target-relevant relational, temporal, material, semantic, or multiscale information not preserved when a historical-relational object is represented through the chosen 2-complex architecture.

Proposition 24.162 (Representation-plurality condition for 2-complexes). A GRE result should not depend on 2-complex-specific properties unless those properties are warranted by the target and materially improve the inference relative to serious alternative representations; otherwise the result should be stated at the more representation-invariant level shared across the alternatives.

This condition keeps the 2-complex available as a powerful tool without allowing one successful representation to become a mandatory ontology or universal syntax.

Proposition 24.163 (Cellular-escalation limit). *Increasing cellular dimension is an appropriate response to a representational failure only when the missing target-relevant structure is principally higher-order incidence, attachment, compositional closure, refinement, or generative genealogy. Failures arising from unsuitable discretization, uncertain boundaries, nonlocal semantics, empirical non-identifiability, or a mismatch between cellular structure and the target object require a different repair or representation family.*

24.7.12 Semantics of History Weights and Amplitude-Like Models

History-space formalisms can assign weights to admissible histories in order to represent plausibility, accessibility, support, transition propensity, institutional favoring, or another typed comparative property. Such weights can be analytically useful because GRE often asks how prior events change later possibility structures rather than only which outcome actually occurred. The limitation is semantic underdetermination. A numerical weight has no automatic meaning merely because it is attached to

a history.

A nonnegative weight might represent a normalized probability, an unnormalized score, a relative accessibility measure, a calibration device, a decision weight, a model-specific propensity, or a heuristic ranking. These interpretations impose different requirements. Probability requires a justified sample space and probability semantics. Accessibility can remain ordinal or comparative and need not satisfy probability axioms. Decision weights concern choice under a particular decision architecture. A score can organize simulation without any direct empirical interpretation. Conflating these meanings creates false precision.

Definition 24.164 (History-weight semantics profile). A *history-weight semantics profile* records the admissible history set, meaning of the assigned weight, scale or normalization, composition and update rules, evidential or calibration basis, dependence on prior events and constraints, interpretation of zero and relative magnitude, and conclusions that remain valid under alternative admissible weight semantics.

Complex-valued or amplitude-like constructions carry a still greater burden. Interference-like composition, phase, complex summation, or other amplitude structures can be mathematically interesting when they represent a substantive compositional feature that simpler nonnegative weights cannot capture. The use of complex numbers alone, however, does not supply a physical interpretation, empirical probability rule, or quantum ontology.

Definition 24.165 (Amplitude-like model burden). The *amplitude-like model burden* is the additional requirement to specify, beyond the ordinary semantics of history weights, why a complex-valued or amplitude-like construction is needed, what its phase and composition rules mean in the receiving GRE problem, how observable or interpretable consequences are obtained, and what analytical result would be lost under a simpler real-valued representation.

This burden is deliberately demanding. Amplitude-like models may eventually prove useful for representing path interaction, incompatible contextual decompositions, compositional histories, or other structures. At the present stage, such possibilities should remain exploratory unless their added structure earns substantive and evidential interpretation.

Proposition 24.166 (History-weight semantic non-identity). *Similarity among history weights does not establish identity of probability, accessibility, value, causal strength, or physical amplitude unless those meanings and their empirical bridges are independently warranted.*

Definition 24.167 (Formalization revision trigger). A *formalization revision trigger* is evidence or argument showing that a GRE formalism materially mis-types its objects or operations, relies on unidentified parameters, suppresses consequential open-system relations, confuses observation with transformation, fails under serious alternative representations, imports unjustified mathematical assumptions, or assigns stronger semantics to formal quantities than the target warrants.

Formalization therefore remains central to GRE, but not sovereign over it. The appropriate ambition is not to maximize mathematical density. It is to construct representations whose additional structure earns its inferential role and whose limits remain visible. A schematic model can be sufficient when the question is conceptual; a structural model can be sufficient when the relevant object is relational organization; a parameterized model can be warranted when measurement and identification sup-

port it; and richer historical, topological, field-theoretic, operator-like, or amplitude-like constructions can be used when they preserve target-relevant distinctions that simpler representations lose. The strongest formal GRE result is consequently one that states not only what follows inside the model, but also why the modeled structure is appropriate, what remains outside it, which empirical bridge supports interpretation, and what evidence would require the formal architecture to change. Section 553 turns to one of the most consequential limits exposed by this discipline: the problem of closure in systems whose relevant relations, rules, and possibility spaces may themselves remain open and historically transformable.

24.8 Closure in Generative Systems

Section 24.7 treated model closure as a formal design decision: some relations are excluded, aggregated, or treated as externally fixed so that a model can become tractable. The present section examines a broader problem. GRE studies processes in which the objects required for description can themselves change. Subjects can emerge or disappear; relation types can be created; institutional boundaries can move; value forms can be recognized or lose force; categories can be reconstituted; and practical action can open or close possibilities that were not available at the beginning of inquiry. The role of this section is therefore to distinguish closure of interactions from closure of the analytical vocabulary and possibility space. Its objective is to clarify when provisional closure is defensible, when higher-order or external dependence defeats it, and how epistemic, institutional, practical, and self-modifying processes should trigger reopening. The method is generative and claim-relative: closure is evaluated by what is being held fixed, for which question, over which boundary and horizon, and whether the supposedly fixed object can itself be transformed by the process under study.

Closure is not inherently a mistake. Inquiry, modelling, institutions, and action all require provisional stabilization. A researcher must decide which actors and relations to investigate; an organization must define membership and authority; a legal system must classify cases; a practical intervention must choose a course of action before every uncertainty is resolved. The problem arises when a local stabilization is interpreted as completeness. A closure adequate for one claim can fail for another, and a closure adequate at one historical moment can be invalidated when the system generates new relations, categories, or possibilities.

Definition 24.168 (Generative closure profile). A *generative closure profile* records, for a specified GRE inquiry, the actors, relations, relation types, categories, value forms, institutional boundaries, environmental exchanges, admissible transformations, and possibility structures treated as fixed or sufficiently stable; the purpose and horizon of that closure; known excluded dependencies; and the conditions under which the closure must be reopened.

The definition extends the closure remainder of Section 24.7. A closure remainder concerns excluded or weakly represented interactions within a formal model. A generative closure profile asks a stronger question: whether the sets and types over which the model reasons can themselves change. Table 24.8 summarizes the main closure problems developed below.

Table 24.8: Closure problems in generative systems

Closure mode	What is provisionally stabilized	Principal reopening condition
Higher-order closure	Lower-order relations or correlations	Higher-order structure changes the mechanism or conclusion
Approximate closure	Selected interactions within a boundary and horizon	Excluded variation exceeds the tolerance relevant to the claim
Institutional closure	Membership, jurisdiction, roles, recognized categories, or procedures	Boundary leakage, contested standing, external dependence, or institutional transformation
Epistemic closure	Working concepts, hypotheses, evidence thresholds, or rival explanations	Material anomaly, new evidence, failed prediction, or alternative explanation
Practical closure	A decision or action set under incomplete knowledge	Changed stakes, consequences, feasibility, reversibility, or evidence
Open-system closure	Environmentally coupled system treated as locally analyzable	External flows or feedback become constitutive for the target claim
Self-modifying closure	Actor, relation, type, rule, or possibility sets	The system generates or removes elements of the assumed analytical vocabulary
Research closure	A provisional stopping rule for the inquiry	Accumulated closure debt or a registered revision trigger

24.8.1 Higher-Order Correlations

Closure can fail even when the relevant actors and relation types are correctly identified. A model can represent pairwise relations accurately while missing structure that exists only at the level of triads, groups, overlapping memberships, sequences of relations, or relations among relations. Chapter 8 and Section 24.5 already established that higher-order structure should not be introduced merely because it is mathematically available. The present problem is complementary: lower-order closure should not be presumed adequate merely because lower-order relations are easier to observe or model.

Consider a coordination process in which no pair of actors has sufficient incentive to act alone, while a three-party commitment changes the feasible action of all participants. Pairwise ties can be measured correctly and still fail to represent the operative coordination structure. Likewise, two organizations can each have ordinary bilateral relations with a regulator, yet the joint arrangement created by shared standards, cross-appointments, or coupled funding can generate a higher-order institutional constraint. The failure is not simply missing data. It is a mismatch between the order at which the process is represented and the order at which the relevant dependence exists.

Definition 24.169 (Higher-order closure gap). A *higher-order closure gap* exists when a GRE representation closed at a specified relational order preserves the represented lower-order relations but omits higher-order configurations whose inclusion would materially change the mechanism, attribution, comparison, or practical conclusion.

Higher-order closure should therefore be tested against the target claim. A dyadic representation can remain sufficient for some questions even when higher-order structure exists. The relevant issue is whether the omitted structure changes what the inquiry is trying to establish.

Definition 24.170 (Relational-order sufficiency profile). A *relational-order sufficiency profile* records the lowest relational order used in an analysis, higher-order configurations considered plausible, evidence concerning their presence, conclusions stable under their inclusion, and conclusions that would require a richer representation.

Proposition 24.171 (Claim-relative order closure). A *lower-order GRE representation*

can be treated as provisionally closed only for claims that remain materially unchanged across serious higher-order specifications compatible with the available evidence.

The proposition prevents two opposite errors. It avoids assuming that every social or economic phenomenon requires the richest possible higher-order model, while also avoiding the reduction of collective structures to dyads by default. Closure at a given order is earned by invariance of the target conclusion, not by computational convenience alone.

24.8.2 Approximate Closure

Most empirically useful closure is approximate rather than exact. An organization interacts with households, suppliers, regulators, technologies, infrastructures, financial institutions, and cultural environments. A local model can nevertheless isolate a subset of these relations when omitted interactions vary slowly, remain weak for the target question, or affect the result only within an acceptable range. The important issue is to state what *acceptable* means.

Approximate closure is therefore not the claim that external influence is absent. It is the claim that, relative to a specified purpose, boundary, horizon, and level of precision, the omitted variation does not alter the relevant inference enough to defeat its use. The same system can be approximately closed for a short-horizon operational question and radically open for a long-horizon generative question.

Definition 24.172 (Approximate closure profile). An *approximate closure profile* specifies the boundary and horizon of the analysis, interactions represented internally, interactions treated as external or fixed, the claim for which closure is sought, the tolerated effect of excluded variation, evidence supporting that tolerance, and sensitivity results under plausible reopening.

The tolerance should be substantive rather than merely numerical. A small change in an aggregate outcome can be unacceptable if it shifts a burden onto a protected population, removes a critical option, changes a legal status, crosses an ecological threshold, or reverses a qualitative conclusion. Conversely, substantial variation in an irrelevant dimension need not invalidate the closure.

Definition 24.173 (Closure tolerance). A *closure tolerance* is the largest class of excluded variation that can occur without changing the substantive status of the target GRE claim, including its direction, mechanism, affected subjects, normative relevance, or decision consequence where those dimensions are part of the claim.

Proposition 24.174 (Approximate-closure validity condition). *Approximate closure is warranted only when the excluded variation remains within a claim-relative closure tolerance over the stated boundary and horizon and when plausible departures from that tolerance are identifiable as reopening conditions.*

This formulation makes closure compatible with open systems. It also makes closure revisable. A relation treated as exogenous today can become endogenous after institutional change; an environmental process treated as slow can become decision-relevant after a shock; an omitted actor can acquire veto power; or a previously negligible platform dependency can become central after technical consolidation. Approximate closure is therefore a versioned judgment rather than a permanent property of the target.

24.8.3 Institutional Closure

Institutions create practical boundaries by defining membership, jurisdiction, property, authority, eligibility, recognized roles, valid procedures, and categories of standing. These boundaries can make complex relations governable. A university defines who counts as a student or faculty member; a court defines jurisdiction and admissible claims; a welfare programme defines eligibility; a corporation defines formal membership and authority; a market infrastructure defines recognized instruments and counterparties. Institutional closure is therefore generative: by closing some classificatory and procedural questions, an institution makes coordinated action possible.

The limit is that institutional boundaries are not necessarily identical to the relational boundaries of the phenomenon. Informal caregivers can sustain an institution without formal membership. Supply-chain workers can bear economic consequences outside the legal boundary of a firm. Ecological effects can cross jurisdictions. Platform users can depend on infrastructures whose governing institutions do not recognize them as participants with standing. Institutional closure can therefore organize action while simultaneously externalizing relations that remain causally or normatively material.

Definition 24.175 (Institutional closure regime). An *institutional closure regime* is the historically situated configuration of rules, categories, memberships, jurisdictions, recognized roles, decision procedures, and boundary practices through which an institution determines what is treated as internal, external, authorized, eligible, or cognizable for a specified purpose.

Definition 24.176 (Institutional closure leakage). *Institutional closure leakage* is the set of causally, economically, socially, ecologically, or normatively consequential relations that cross an institutional closure regime while remaining weakly represented, unrecognized, or formally external to the institution's operative categories.

Leakage does not make institutional closure illegitimate by itself. Any organization requires boundaries. The analytical task is to distinguish boundary functionality from boundary adequacy. A boundary can be administratively necessary while still generating externalities, invisibility, or contested standing that require another analytical layer.

Proposition 24.177 (Institutional closure non-completion). *The existence of a stable institutional boundary, category, or jurisdiction should not be interpreted by GRE as evidence that the economically or relationally relevant system is correspondingly closed.*

The proposition also protects the distinction between institutional and ontological closure developed earlier in the book. A working institutional category can be indispensable for coordination while remaining provisional as a description of the underlying relational configuration.

24.8.4 Epistemic Closure

Inquiry cannot remain indefinitely open to every concept, hypothesis, category, and rival explanation. Research requires provisional stabilization of questions, evidence standards, measurement rules, interpretive frames, and stopping conditions. Chapter 6 described the contradiction between provisional epistemic closure and revisability. Chapter 24 now treats that contradiction as a limitation problem: closure permits cumulative inquiry, but it can also suppress alternatives prematurely and make in-

herited categories self-confirming.

Epistemic closure can occur at several levels. A field can stabilize a vocabulary; a project can fix an operational definition; a statistical analysis can define an estimand; a historical inquiry can delimit a reconstruction range; or an interdisciplinary team can agree that certain premises will be taken as given. None of these choices implies finality. The problem is whether the closure remains visible as a methodological commitment and whether evidence capable of reopening it is still admissible.

Definition 24.178 (Epistemic closure state). An *epistemic closure state* is a provisional research configuration in which specified concepts, hypotheses, categories, evidential thresholds, or explanatory alternatives are stabilized sufficiently for cumulative inquiry, while their grounds, excluded alternatives, and reopening conditions remain recorded.

Definition 24.179 (Epistemic reopening trigger). An *epistemic reopening trigger* is evidence or argument that materially challenges a stabilized assumption, reveals a relevant excluded alternative, changes the interpretation of key evidence, exposes category failure, or shows that the current closure suppresses a distinction necessary for the target claim.

A research programme can become epistemically brittle when its core concepts absorb anomalies by re-description rather than permitting them to count against the framework. The limitation is especially serious for GRE because relational and generative vocabulary is flexible. Almost any process can be redescribed as involving relations or generation at some level. Closure discipline must therefore work together with the failure conditions developed later in this chapter.

Proposition 24.180 (Reopenable epistemic closure). *Epistemic closure strengthens GRE only when it reduces the active hypothesis space for a stated purpose while preserving identifiable evidence and arguments capable of reopening the stabilized concepts, categories, or explanations.*

This proposition prevents openness from becoming indefinite skepticism and closure from becoming doctrinal immunity. The appropriate balance is a research configuration that can proceed decisively while retaining structured routes for correction.

24.8.5 Practical Closure

Application-dominant praxis adds a distinct closure requirement. Decisions often cannot wait for epistemic completion. Governments adopt temporary measures, organizations allocate resources, clinicians choose interventions, researchers terminate data collection, communities act under threat, and institutions commit to infrastructures whose effects unfold before uncertainty disappears. Practical closure is the stabilization required to act.

Practical closure must therefore be distinguished from epistemic closure. A decision can be provisionally warranted while the underlying explanation remains contested. Conversely, an epistemically well-supported conclusion does not by itself determine which action should be chosen because action also depends on values, rights, distribution, feasibility, reversibility, timing, and institutional authority.

Definition 24.181 (Practical closure profile). A *practical closure profile* records the decision or action being stabilized, the evidence and uncertainties present at the point

of commitment, affected subjects, unresolved value conflicts, feasible alternatives, reversibility, monitoring architecture, revision triggers, and the consequences of both action and delay.

A practical closure can be intentionally temporary. Pilot programmes, sunset clauses, staged deployment, reversible defaults, contingency rules, monitoring thresholds, and reserved resources for repair can convert uncertainty into design constraints. This does not eliminate risk, but it prevents action from silently transforming a provisional judgment into irreversible institutional fact.

Definition 24.182 (Closure irreversibility burden). The *closure irreversibility burden* is the additional evidential, participatory, normative, and monitoring burden created when a practical closure removes future options, entrenches dependencies, creates difficult-to-reverse institutions, or redistributes the ability of affected subjects to contest and revise the decision.

Proposition 24.183 (Practical closure non-equivalence). *A justified practical closure should not be interpreted as epistemic completion, normative consensus, or proof that the selected action exhausts the feasible or legitimate alternatives.*

The proposition is central to a generative framework because practical closure changes later possibility. A temporary decision can generate infrastructures, expectations, capabilities, sunk costs, legal entitlements, organizational routines, and dependencies that make reopening progressively harder. Closure therefore has a history: what begins as a reversible decision can become structurally entrenched.

24.8.6 Open Systems

GRE frequently studies open systems. Economic configurations depend on material inputs, ecological conditions, legal environments, information flows, technologies, migration, finance, political authority, cultural meanings, and relations that cross any chosen analytical boundary. Openness does not make analysis impossible. It means that local closure must be justified through the relevance of cross-boundary exchange to the target claim.

The term *open system* can itself become too permissive if every external influence is treated as equally relevant. A system boundary remains analytically useful when it identifies a configuration whose internal relations support a coherent question while external exchanges are explicitly typed. The discipline is therefore neither complete isolation nor boundarylessness, but structured openness.

Definition 24.184 (Open-system exchange profile). An *open-system exchange profile* records the principal material, informational, financial, legal, ecological, technological, human, and symbolic flows crossing a chosen GRE boundary, their direction and temporal scale, the mechanisms through which they affect the focal configuration, and which flows are treated as endogenous, exogenous, or presently unresolved.

Definition 24.185 (Local analytical closure). *Local analytical closure* is a claim-relative condition under which a bounded representation of an open system remains adequate because cross-boundary exchanges omitted or externally specified do not materially alter the target conclusion over the stated horizon and scale.

Local closure can fail through environmental change, policy shifts, infrastructure breakdown, migration, technological substitution, strategic adaptation, or any other process that changes the importance of cross-boundary flows. A model that was ade-

quate before such a change need not remain adequate afterward.

Proposition 24.186 (Open-system closure condition). *GRE may use local analytical closure for an open system when the relevant cross-boundary exchanges are typed, the excluded flows are represented in the closure remainder, and the target conclusion is robust to plausible variation in those flows over the stated horizon.*

This proposition makes open-system reasoning compatible with tractability. It also prevents a boundary choice from erasing the environment on which the focal configuration depends.

24.8.7 Self-Modifying Systems

The strongest closure challenge arises when the system changes not only its state but the categories through which its possible states are described. A market can create a new financial instrument; a legal order can create a new status; a technology can generate a new class of activity; an organization can create a new role; a social movement can produce a new collective subject; an educational system can recognize a new capability; an AI-mediated environment can create forms of coordination or dependence that did not previously exist. In such cases, evolution occurs partly through modification of the analytical vocabulary itself.

This problem should be distinguished from ordinary state change. A fixed-state model allows variables to change within a predetermined space. A self-modifying generative system can change the variable set, admissible relation types, transition rules, boundary criteria, value categories, or feasible action set. The question is not merely which state follows, but whether the state space used to formulate the question remains adequate.

Definition 24.187 (Type-space closure). *Type-space closure* is the assumption that the classes of subjects, relations, categories, values, institutional roles, or transformations relevant to an analysis remain sufficiently fixed over the stated horizon that new types do not need to be introduced for the target claim.

Definition 24.188 (Possibility-space closure). *Possibility-space closure* is the assumption that the set or generative description of feasible states, actions, institutional forms, or trajectories relevant to an analysis remains sufficiently stable over the stated horizon that materially novel possibilities need not be represented.

Both assumptions can be useful locally. They become problematic when generation itself concerns novelty. A theory of innovation that assumes a fixed set of products can model selection among known alternatives while missing the generation of new product categories. A theory of institutional reform that assumes fixed legal statuses can model redistribution within the existing order while missing status creation. A theory of participation that assumes fixed subjects can miss the emergence of new collective actors.

Definition 24.189 (Generative closure failure). A *generative closure failure* occurs when a process generates, removes, or materially reconstitutes subjects, relation types, categories, value forms, rules, boundaries, or feasible possibilities that were treated as fixed, and the resulting novelty changes the explanatory or practical conclusion.

Self-modification can also alter the rules by which later modification occurs. New technologies can change the speed of coordination; new law can change who has au-

thority to create subsequent law; new infrastructures can change the cost of forming relations; new AI systems can alter knowledge production and hence the conditions under which later technologies are generated. Such processes create second-order generativity: generation changes the generative mechanism.

Definition 24.190 (Generative-rule modification). *Generative-rule modification* occurs when a historical process changes the mechanisms, constraints, admissible transformations, or selection conditions that govern how later subjects, relations, categories, institutions, values, or possibilities can be generated.

Proposition 24.191 (Self-modifying closure constraint). *Where type-space closure, possibility-space closure, or the operative generative rules are themselves materially transformed, GRE should treat the original closure as historically local and reconstitute the analytical space before extending conclusions across the transformation.*

This proposition places a limit on fixed state-space modelling without rejecting it. Fixed spaces can remain powerful approximations within periods of relative stability. The limitation arises when the phenomenon of interest is precisely the production of new dimensions, types, rules, or possibilities.

24.8.8 Closure as Research Problem

The preceding subsections suggest that closure should become an explicit object of GRE research rather than a hidden prerequisite. Every inquiry closes some questions provisionally. The relevant task is to determine which closures are necessary, which are harmless for the target claim, which generate systematic blind spots, and which are themselves changed by the process under investigation.

Definition 24.192 (Closure audit). A *closure audit* is a structured examination of an inquiry's relational order, system boundary, temporal horizon, institutional boundary, epistemic stopping rules, practical commitments, environmental exchanges, type space, possibility space, generative rules, and reopening conditions, together with the conclusions that depend materially on each closure.

The audit is not a demand to reopen everything simultaneously. Complete openness would make cumulative inquiry and practical coordination impossible. Its purpose is to make selective stabilization inspectable and to identify where closure carries the greatest risk of distorting the target.

Definition 24.193 (Closure debt). *Closure debt* is the accumulated research liability created when provisional closures continue to support later claims after their original justification, boundary, horizon, or reopening conditions have become unclear, outdated, or untested.

Closure debt can accumulate gradually. A simplified category becomes standard; later datasets inherit it; models are calibrated to those data; policies use the resulting outputs; and subsequent research treats the category as an empirical fact because it appears consistently across the accumulated evidence. The resulting stability can be produced partly by repeated closure rather than by stability of the underlying phenomenon.

Definition 24.194 (Closure revision trigger). A *closure revision trigger* is evidence or analysis showing that a higher-order configuration, excluded interaction, institutional leakage, epistemic anomaly, practical consequence, cross-boundary exchange, newly generated type, changed possibility space, or modified generative rule materi-

ally affects a conclusion that depended on the previous closure.

Proposition 24.195 (Reopenable closure principle). *GRE should prefer the least expansive closure sufficient for the target question while preserving explicit reopening conditions for dimensions whose excluded variation could materially alter the conclusion.*

The principle is deliberately asymmetric. It does not require maximal openness. It requires that closure do no more work than its evidence can support. A narrow local model can therefore be stronger than an apparently comprehensive model when its boundary, horizon, and reopening conditions are better justified.

Closure also provides a useful research agenda. Empirical work can test whether conclusions survive reopening at higher relational order, across wider institutional or ecological boundaries, under alternative categories, or after newly generated possibilities are introduced. Historical work can examine when once-adequate closures failed as institutions or technologies changed. Formal work can develop representations in which actor sets, relation types, or state spaces can expand. Comparative work can identify domains in which approximate closure is reliable and domains in which self-modification makes closure especially fragile.

The closure problem therefore returns GRE to one of its defining concerns: generation changes the conditions of later generation. A framework designed to study such processes cannot assume globally fixed subjects, relations, categories, values, institutions, or possibility spaces without qualification. It can close them locally, approximately, and provisionally when the target question permits. The theoretical obligation is to record what has been closed, why that closure is useful, what remains outside it, and what would require reopening.

The next section turns to value-theoretical limits. Having clarified when the analytical field itself can be provisionally stabilized, the chapter can ask a different question: whether GRE can reliably identify and distinguish the value forms operating within that field, especially where intrinsic, instrumental, relational, generative, future, and conflicting values resist a single taxonomy.

24.9 Value-Theoretical Limits

The book's value architecture has deliberately resisted a single measure of economic significance. Earlier chapters distinguished situated value attribution, heterogeneous value forms, relational and generative processes, conversion, circulation, recognition, conflict, future consequence, and historically revisable value taxonomies. The role of the present section is not to repeat that architecture but to identify its limits. Its objective is to specify where value forms can be responsibly identified, where familiar distinctions such as intrinsic and instrumental value remain ambiguous, where generative and relational value claims require additional warrants, how future value and conflict enlarge uncertainty, and why the GRE value taxonomy must remain open to expansion, contraction, retyping, and domain-specific correction. The method is diagnostic and claim-relative. A value claim is examined through its bearer, valuing position, evaluative standpoint, realization conditions, temporal horizon, manifestation and recognition regime, comparison rule, and the evidence that would distinguish it from rival value descriptions.

Value theory creates a special difficulty for GRE because the vocabulary of value op-

Table 24.9: Value-theoretical limits in GRE

Limit	Principal risk	Required discipline
Value-form identification	One manifestation or consequence is mistaken for a distinct form of value	Compare realization conditions, bearers, warrants, and rival classifications
Value relation	Final, intrinsic, instrumental, enabling, and constitutive relations are collapsed	State the evaluative relation and avoid inferring intrinsic status from non-market or non-instrumental use
Generative value	Generation is equated with goodness or socially desirable expansion	Separate generated consequence from the evaluative rule applied to it
Relational value	Any relation-dependent effect is called relational value	Specify whether value lies in, through, because of, or normatively within the relation
Future value	Long-horizon significance is asserted beyond evidential reach	State horizon, uncertainty, inheritance, option, and discounting assumptions
Value conflict	A practical settlement is mistaken for theoretical resolution	Preserve unresolved claims, burdens, and affected positions after decision
Value plurality	Plurality becomes either forced aggregation or unrestricted incomparability	Localize comparison rules and retain remainders
Value taxonomy	Existing categories become self-confirming or historically frozen	Keep category provenance, anomaly registers, and revision triggers explicit

erates simultaneously at descriptive, interpretive, institutional, and normative levels. A price is an observable economic representation. A legally recognized entitlement can confer practical standing. A community can regard a practice as worth preserving. An analyst can infer that a capability expands later possibilities. A moral theory can claim that a condition is valuable independently of whether anyone presently recognizes it. These statements do not have the same warrant merely because each uses the language of value. The first limitation is therefore semantic and epistemic: GRE must state what kind of value claim is being made before asking how that value is generated, converted, circulated, protected, or lost.

Definition 24.196 (Value-claim profile). A *value-claim profile* records, for a specified GRE claim, the object or condition treated as value-bearing, the valuing or affected positions, the evaluative standpoint, the asserted value form, the mode of realization or recognition, the temporal horizon, the relevant comparison or non-comparison rule, the evidential basis, and the normative commitments required for the claim.

The profile makes visible several failure points. A value form can be misidentified because a manifestation is mistaken for the underlying value-bearing condition. An instrumental contribution can be confused with value for its own sake. A generative effect can be treated as good merely because it generates more options. A relation can be assigned value because it is persistent even when persistence is burdensome. Future effects can be asserted with confidence unsupported by the horizon of the evidence. A taxonomy can become self-confirming because research instruments detect only the value forms they were designed to represent.

Table 24.9 summarizes the principal value-theoretical limitations developed in this section.

24.9.1 Identification of Value Forms

A value form is useful only if it performs analytical work that would be lost by treating it as another already recognized form. Chapter 14 used material, financial, capability, relational, epistemic, institutional, participatory, option, future, and ecological value as a working taxonomy. Chapter 22 subsequently made the taxonomy explic-

itly researchable and revisable. The limitation is that the evidence encountered in an inquiry does not arrive already sorted into these categories. Researchers select indicators, interpret practices, infer realization conditions, and decide which distinctions are sufficiently stable to warrant a separate value form.

The presence of a distinctive manifestation is not sufficient. A new index, score, budget category, or institutional label can create a new representation without disclosing a new value form. Likewise, the existence of a different bearer is not sufficient. The same form of value can be instantiated by individuals, organizations, communities, infrastructures, or ecological configurations. A separate value form becomes analytically useful when the conditions of realization, loss, conversion, recognition, comparison, or conflict differ materially enough that collapsing the cases changes the explanation or evaluation.

Definition 24.197 (Value-form identification dossier). *A value-form identification dossier records the proposed value form, candidate bearers, realization conditions, characteristic manifestations, recognition mechanisms, conversion interfaces, relevant temporal horizon, rival classifications, and the explanatory or evaluative distinctions that would be lost if the proposed form were collapsed into an existing category.*

Proposition 24.198 (Value-form differentiation condition). *A proposed GRE value form is warranted only when its differentiation preserves materially relevant realization, conversion, recognition, conflict, temporal, or evaluative structure that would be obscured by the serious alternative classifications available for the inquiry.*

The condition is intentionally demanding. It prevents the taxonomy from expanding whenever a researcher encounters a novel object. A new technology can carry material, financial, capability, epistemic, relational, institutional, or future value without requiring a distinct “technology value” category. Conversely, an existing broad category can become inadequate if comparative research repeatedly reveals several realization mechanisms with different incidence, conversion pathways, or normative implications.

Identification is also sensitive to observation and representation. Section 24.4 showed that institutional categories and metrics can create apparent distinctions that are partly artifacts of manifestation regimes. Value-form research must therefore ask whether an observed boundary reflects a difference in value-bearing conditions or merely a difference in how those conditions are measured, administered, or narrated.

Definition 24.199 (Value-form identification uncertainty). *Value-form identification uncertainty is uncertainty concerning whether an observed pattern warrants a distinct value category, belongs within an existing form, represents a conversion or manifestation of another form, or reflects a classification effect generated by the inquiry or institution itself.*

Identification uncertainty does not require suspension of all value analysis. A study can proceed with a provisional category if its status is explicit and if the conclusions do not depend on treating the category as ontologically final or universally portable.

24.9.2 Intrinsic and Instrumental Value

The distinction between intrinsic and instrumental value remains useful, but GRE inherits the ambiguity of the wider value-theoretical vocabulary. Something can be valued as an end, valued independently of a particular consequence, valued because of its internal properties, valued because a relation partly constitutes the good, or valued because it enables another valued condition. These are not equivalent claims. In particular, non-instrumentality does not by itself establish intrinsic value in a stronger relation-independent sense.

GRE therefore treats intrinsic and instrumental descriptions as indexed claims rather than as universal properties attached once and for all to an object. Money may be instrumental in one analysis; participation may be instrumentally valuable because it improves information and also valued as a constitutive feature of political standing; an ecological condition may be treated as instrumental to production within one economic model while another evaluative framework attributes non-instrumental value to it. The analytical requirement is not to choose one vocabulary globally, but to specify which relation is asserted and whose evaluative framework licenses it.

Definition 24.200 (Value-relation specification). A *value-relation specification* identifies whether a value claim concerns contribution to another end, enabling capacity, constitutive participation in an end, value for its own sake, relation-dependent significance, or another explicitly stated evaluative relation, together with the standpoint and conditions under which the relation is asserted.

Proposition 24.201 (Intrinsic-status non-inference). *The absence of an identified instrumental use, market price, exchange relation, or downstream consequence does not by itself establish intrinsic value; intrinsic or final status requires an independent evaluative warrant appropriate to the domain and claim.*

A symmetrical restraint applies to instrumentality. A condition can contribute causally to another valued outcome without being interchangeable with other means. Trust can support coordination but can also carry relation-specific significance. Education can increase earnings while also constituting capability, social participation, or epistemic standing. Treating these objects as merely instrumental can therefore erase dimensions that matter to the inquiry.

Definition 24.202 (Instrumental non-exhaustion). *Instrumental non-exhaustion* obtains when an object, relation, or condition has an identifiable contribution to another valued end while additional value claims concerning the same object remain materially relevant and are not represented by that contribution.

The resulting limitation is one of classification, not skepticism. GRE can use instrumental analysis strongly where the research question concerns causal contribution. It should simply avoid converting one valid instrumental relation into a complete account of value.

24.9.3 Generative Value

Generative value is central to GRE because economic processes can matter through the later capacities, relations, options, institutions, knowledge, and conditions they help create or preserve. The concept is also unusually vulnerable to overreach. Generation is a descriptive property of a process relative to a specified outcome space;

value is an evaluative attribution. A process can generate many later possibilities while generating harmful dependencies, exploitative relations, ecological burdens, or institutional fragility. Conversely, preservation or restraint can be valuable even when it generates few novel options.

The limitation therefore concerns the bridge between generative description and value attribution. Calling an effect “generative value” is defensible only when both parts of the expression are warranted: the relevant effect must be attributable to the process with appropriate strength, and the generated or preserved condition must have a separately specified evaluative standing.

Definition 24.203 (Generative-value warrant). A *generative-value warrant* combines an empirically or interpretively supported generative attribution with an explicit value claim concerning the generated, preserved, regenerated, or made-accessible condition, including the relevant subjects, horizon, evaluative standpoint, and competing burdens.

Proposition 24.204 (Generativity–goodness separation). *Evidence that a process increases generativity, option production, relational proliferation, institutional capacity, or later transformation does not by itself establish that the generated consequences are desirable, just, welfare-enhancing, or worthy of preservation.*

Generative value also depends on what is counted as generation. A university may generate publications, skills, networks, credentials, organizations, or public knowledge. A platform may generate interactions while degrading autonomy or concentrating control. A policy may create near-term employment while narrowing later ecological possibilities. The choice of generated object can therefore predetermine the apparent value of the process if burdens and foreclosed possibilities are omitted.

Definition 24.205 (Generative-value scope profile). A *generative-value scope profile* records the generated or preserved objects counted in the analysis, affected subjects, positive and negative consequences, foreclosed alternatives, distribution across positions, temporal horizon, and the value rule under which the resulting generative pattern is evaluated.

Proposition 24.206 (Selective-generation warning). *A generative-value assessment is incomplete when it counts generated capacities, options, relations, or outputs that support the favored conclusion while omitting materially connected harms, dependencies, closures, or displaced possibilities produced by the same process.*

The concept should therefore remain narrower than “everything that creates something.” Its analytical advantage lies in tracing how present configurations condition later possibility and capacity, not in assigning automatic normative priority to expansion or novelty.

24.9.4 Relational Value

Relational value has several legitimate but non-equivalent meanings. Value can be *carried by* a relation, as when trust or coordination supports access and capability. Value can be *realized through* a relation, as when collaboration makes an achievement possible. The relation itself can be part of what participants value, as in friendship, care, membership, or shared practice. A normative framework can also evaluate the quality or appropriateness of a relationship. These claims should not be collapsed merely because each is relational.

The limitation is especially important for GRE because the framework already gives relations analytical prominence. Without additional discipline, any valuable object could be redescribed as relational simply because its realization depends on some surrounding relation. Such semantic expansion would make relational value nearly universal and therefore weakly discriminating.

Definition 24.207 (Relational-value mode). A *relational-value mode* specifies whether the value claim concerns a relation as a valued good, a relation as an enabling or constitutive condition of another value, a relational position that changes economic significance, or a normative evaluation of how subjects ought to relate.

Proposition 24.208 (Relational-value discrimination condition). *GRE should describe a value claim as relational only when identifying the relevant relation or relational position adds material explanatory or evaluative discrimination beyond stating that the valued condition occurs within a generally relational environment.*

Relational value can also be negative or mixed. Dependence can provide security and constrain exit. Membership can create solidarity and exclusion. Dense coordination can generate capability and surveillance. Persistent relation-specific assets can support continuity while creating lock-in. The value of a relation should therefore not be inferred from its strength, density, stability, or duration alone.

Definition 24.209 (Relational-value ambivalence profile). A *relational-value ambivalence profile* records the beneficial, harmful, enabling, constraining, constitutive, positional, and distributional dimensions of a relation for materially affected positions rather than assigning one undifferentiated value sign to the relation as a whole.

This profile also limits transfer across contexts. A relational configuration valuable in one institutional setting can become burdensome under another because exit rights, power asymmetries, information, legal protections, or alternative relations change. Relational value is therefore often historically and positionally indexed.

24.9.5 Future Value

Future value is necessary for a generative framework because many economically significant consequences appear only after delay. Education, ecological restoration, scientific infrastructure, institutional capacity, preventive health, maintenance, and option preservation can require present expenditure for uncertain future realization. Yet the further the horizon extends, the more strongly value claims depend on assumptions about future subjects, technologies, institutions, preferences, ecological conditions, discounting, inheritance, and the persistence of conversion pathways.

Future value therefore combines ordinary uncertainty with a problem of future standpoint. Current actors can estimate later consequences, but future subjects may evaluate inherited conditions differently. Some future value claims concern benefits to identifiable later persons; others concern maintaining capacities, ecological conditions, knowledge, institutional options, or possible trajectories whose eventual beneficiaries cannot yet be specified.

Definition 24.210 (Future-value horizon profile). A *future-value horizon profile* records the temporal horizon of a value claim, projected value-bearing conditions, expected beneficiaries or affected positions where identifiable, uncertainty sources, persistence and maintenance assumptions, conversion assumptions, discounting or weighting rules where used, and conditions under which later re-evaluation could

revise the present claim.

Proposition 24.211 (Future-value uncertainty condition). *The evidential strength of a future-value claim cannot exceed the warrant for the causal, institutional, ecological, technological, and evaluative assumptions required to connect the present configuration to the asserted future significance.*

This proposition does not imply that distant consequences should be ignored because they are uncertain. Ignoring them is itself an evaluative and temporal choice. The appropriate response is to distinguish uncertainty from absence and to report which conclusions depend on which future assumptions.

Future value also interacts with option value. Preserving an option can be valuable because later actors retain the ability to choose under improved information. But option expansion is not always beneficial. A large option set can be costly to maintain, strategically manipulated, inaccessible to some positions, or composed largely of undesirable possibilities. The value of optionality therefore depends on practical reachability, affected subjects, maintenance cost, reversibility, and the quality of the alternatives preserved.

Definition 24.212 (Future-value remainder). *A future-value remainder is a materially relevant long-horizon consequence, affected future position, preserved or foreclosed possibility, or uncertainty that is not captured by the operative present valuation, discounting rule, or decision metric.*

Future-value analysis is strongest when it preserves such remainders rather than converting every distant consequence into a single present-equivalent quantity.

24.9.6 Value Conflict

Value conflict arises when economically relevant value claims cannot all be realized, protected, recognized, or prioritized under the available conditions. Conflict can occur among value forms, among subjects, across generations, between local and system-level consequences, or between economic valuation and legal, political, ecological, educational, or other domain-specific evaluative authorities. The limit for GRE is that describing the conflict does not by itself provide the rule for resolving it.

A project can generate employment while damaging an ecological relation. A platform can increase access while weakening privacy or bargaining power. A research programme can generate knowledge while imposing burdens on participants. An institution can preserve continuity for current members while narrowing entry for later participants. GRE can reconstruct these relations, identify affected positions, trace conversion and distribution, and show how power conditions the settlement. Those achievements do not automatically determine which value should prevail.

Definition 24.213 (Value-conflict topology). *A value-conflict topology records the value claims in conflict, their bearers or affected positions, realization conditions, incompatibilities, available compromises or sequencing options, power over the decision interface, comparison rules used, and value remainders left unresolved by each feasible settlement.*

Proposition 24.214 (Conflict-description non-resolution). *A complete relational description of a value conflict does not by itself establish the normatively justified resolution unless the evaluative rule that licenses the resolution is independently warranted.*

Institutional settlement should likewise be distinguished from theoretical resolu-

tion. Markets, courts, organizations, elections, expert procedures, community practices, or administrative rules can produce a decision. The fact that a procedure settles the issue can be economically and politically consequential, yet it does not establish that the competing value claims have become commensurable or that the residual loss has disappeared.

Definition 24.215 (Settlement–resolution gap). The *settlement–resolution gap* is the difference between achieving a practically operative decision concerning conflicting value claims and establishing that the underlying evaluative disagreement, burden, or remainder has been normatively or conceptually resolved.

This gap is essential for later analysis of power and justice. The ability to impose a settlement can determine which value becomes actionable without determining which value is justified.

24.9.7 Value Plurality

Value plurality is one of GRE’s central working commitments, but it too has limits. Plurality can be overstated if every evaluative difference is treated as a distinct value form; it can be understated if all values are forced onto one metric because practical decisions require comparison. The theoretical problem is to distinguish plurality of value-bearing conditions, plurality of evaluative standpoints, plurality of measurement scales, and plurality of normative principles.

These forms of plurality can coincide without being identical. Two groups can disagree about one value while using the same metric. One institution can recognize several value forms under one procedural rule. Several metrics can represent different manifestations of the same underlying concern. A normative dispute can persist even when empirical values are agreed. GRE therefore needs to type the plurality before drawing conclusions about commensurability or conflict.

Definition 24.216 (Value-plurality profile). A *value-plurality profile* distinguishes plurality of value-bearing conditions, value forms, valuing or affected positions, evaluative standpoints, representations, comparison rules, and normative principles within a specified inquiry.

Proposition 24.217 (Plurality non-incommensurability condition). *The presence of multiple value forms or evaluative standpoints does not by itself establish that comparison is impossible; comparability and incommensurability must be localized to a specified operation, purpose, and domain.*

The converse is equally important. The existence of a practical comparison does not prove that the underlying values are equivalent. Budgeting, cost-effectiveness rules, legal damages, voting procedures, rankings, multicriteria methods, and negotiated settlements can all create local commensuration while leaving conceptual, experiential, ecological, or normative remainders.

Definition 24.218 (Plurality-preserving comparison). A *plurality-preserving comparison* is a decision or analytical procedure that makes specified value claims comparable for a bounded purpose while recording the comparison rule, dimensions excluded from it, affected positions, and material remainders not represented by the common decision space.

Value plurality therefore supports neither automatic aggregation nor automatic refusal to compare. The appropriate position is local: identify the comparison being

attempted, the values it preserves, the values it transforms, and the remainders it leaves unresolved. The next section examines this problem directly through heterogeneous value and incommensurability.

24.9.8 Limits of Value Taxonomy

The final limitation concerns the taxonomy itself. A value taxonomy is a research instrument: it organizes inquiry, supports comparison, and helps identify conversion or conflict. It is not a completed inventory of everything that can be valuable. The existing GRE taxonomy emerged from the problems developed in this book, and its usefulness must therefore remain conditional on future historical, comparative, empirical, and cross-domain research.

Taxonomies face at least four risks. First, *category inflation* occurs when every novel object receives a new value label. Second, *category compression* occurs when materially different realization or evaluative structures are merged because one familiar category is convenient. Third, *category lock-in* occurs when data collection and institutions reproduce inherited categories until their persistence is mistaken for naturalness. Fourth, *category export* occurs when a value form developed in one domain is transferred elsewhere without reconstructing its realization and evaluative conditions.

Definition 24.219 (Value-taxonomy adequacy profile). A *value-taxonomy adequacy profile* records which GRE value forms are used in an inquiry, distinctions each form preserves, overlaps among forms, unresolved cases, domain-specific additions or exclusions, observed anomalies, and the conclusions that materially depend on the taxonomy chosen.

Definition 24.220 (Value-taxonomy anomaly). A *value-taxonomy anomaly* is an empirically, interpretively, or normatively relevant value-bearing pattern that cannot be represented adequately within the current taxonomy without systematic ambiguity, loss of discrimination, forced commensuration, or contradiction among category rules.

An anomaly should not automatically produce a new category. It can indicate poor measurement, an unrecognized conversion process, context-specific variation, or an overly broad existing form. Repeated anomalies across independent inquiries nevertheless provide evidence that the taxonomy may require revision.

Definition 24.221 (Value-taxonomy revision trigger). A *value-taxonomy revision trigger* is accumulated evidence that the current taxonomy systematically collapses materially different value structures, proliferates distinctions without explanatory gain, fails to represent recurrent value-bearing conditions, or transports categories across domains in ways that distort the target phenomenon.

Proposition 24.222 (Open value-taxonomy principle). *GRE should treat its value taxonomy as a versioned analytical portfolio whose categories can be retained, subdivided, merged, retyped, localized, or abandoned according to their demonstrated explanatory, empirical, interpretive, and evaluative performance.*

This principle is consistent with the closure discipline of Section 24.8. Value analysis often requires temporary type-space closure so that empirical work can proceed, but generative and historical processes can produce value-bearing conditions that were not captured by the original vocabulary. A fixed taxonomy would therefore be

especially problematic in a framework whose substantive object includes the generation and transformation of value itself.

The limits identified in this section do not weaken the case for heterogeneous value. They specify the conditions under which heterogeneous-value analysis remains discriminating rather than merely expansive. Value forms must be identified rather than assumed; intrinsic, instrumental, generative, and relational claims must retain their distinct warrants; future claims must expose their horizon and uncertainty; conflicts must preserve unresolved remainders; and plurality must not be converted either into forced aggregation or into unrestricted incomparability. The taxonomy remains useful precisely because it remains revisable.

The next section narrows the problem to commensurability. Once value forms and evaluative standpoints are treated as plural but revisable, GRE must ask which comparisons can legitimately be constructed across heterogeneous values, where common measures fail, how institutions create local commensuration, and what remains when aggregation is not warranted.

24.10 Heterogeneous Value and Incommensurability

Section 24.9 established that GRE's heterogeneous-value vocabulary must remain typed, revisable, and explicit about the warrants that support different value claims. The present section addresses a narrower but more difficult problem: what follows when several value forms are simultaneously relevant but cannot be represented adequately by one common measure. Its role in Chapter 24 is therefore to specify the limits of comparison itself. The section distinguishes partial commensurability from stronger commensurability, local and institutional commensuration from value identity, forced commensuration from legitimate practical comparison, and translation from measurement. It then develops the idea of residual value and closes by identifying conditions under which aggregation becomes analytically or normatively misleading.

The method is deliberately local. GRE should not label two values simply “commensurable” or “incommensurable” without specifying the operation for which comparison is attempted, the domain and decision context, the affected positions, the comparison rule, and the dimensions that remain outside the comparison. Incommensurability is therefore treated neither as a metaphysical property that automatically attaches to certain value forms nor as an obstacle that disappears whenever an institution produces a decision. The relevant question is which distinctions a proposed comparison preserves, which it transforms, and which it leaves unresolved.

Table 24.10 summarizes the limitation architecture developed in this section.

24.10.1 Partial Commensurability

Comparison among heterogeneous values need not be all-or-nothing. Two value claims can be comparable with respect to one practical question while remaining non-equivalent in other respects. A policy can be compared with alternatives by financial cost while leaving ecological, relational, participatory, or future-value dimensions outside the monetary comparison. Two educational programmes can be compared by completion rates while remaining differently valuable with respect to

Table 24.10: Commensurability limits in heterogeneous-value analysis

Problem	Principal risk	Required discipline
Partial commensurability Non-commensurability	Bounded comparability is expanded into general equivalence Local comparison failure is generalized into absolute incomparability	State the operation, dimensions, horizon, and excluded value claims Identify the failed operation and test alternative comparison procedures
Local commensuration	A temporary common scale is mistaken for value identity	Preserve scope, purpose, reversibility, and remainder
Institutional commensuration	Institutional decision rules acquire unwarranted evaluative authority	Separate operative settlement from substantive justification
Forced commensuration	Power-created comparability is treated as neutral measurement	Record coercion, exclusion, burden allocation, and unavailable alternatives
Translation without measure	Interpretive correspondence is confused with quantitative conversion	Preserve semantic asymmetry and non-equivalent dimensions
Residual value	Unrepresented dimensions disappear after decision	Record what remains valuable, harmed, foreclosed, or contested
Aggregation	A scalar result conceals heterogeneity, distribution, or threshold effects	State aggregation rule, weights, losses, and non-aggregable conditions

curiosity, judgment, belonging, or long-run capability generation. Partial commensurability therefore concerns the bounded construction of a common comparison space rather than the discovery of a universal value metric.

Definition 24.223 (Partial-commensurability profile). A *partial-commensurability profile* records the value forms compared, the specific operation for which comparison is possible, the shared dimensions or decision variables, the comparison rule, the temporal and institutional scope, and the value dimensions that remain outside the common comparison space.

The profile matters because the same pair of value claims can be comparable for one purpose and non-comparable for another. Financial cost and ecosystem restoration can be compared for purposes of a budget constraint without thereby establishing that ecosystem value is financially constituted. Capability gains and administrative burden can be jointly considered in programme design without becoming instances of one underlying value substance.

Proposition 24.224 (Operation-relative commensurability condition). *A claim that heterogeneous values are commensurable is warranted only relative to a specified comparison operation whose rule preserves the distinctions required by the inquiry; success of that operation does not establish unrestricted value equivalence.*

Partial commensurability can be analytically valuable because economic and institutional decisions frequently require comparison without requiring a complete ordering of values. The limitation arises when a bounded comparison is silently generalized. A cost threshold, ranking procedure, compensation schedule, or multicriteria score may solve one coordination problem while remaining inadequate for questions of justice, identity, irreversibility, or long-run generativity.

Definition 24.225 (Overextended commensurability). *Overextended commensurability* occurs when a comparison rule justified for a bounded operation is used to infer equivalence, ranking, substitution, or compensation beyond the dimensions, domain, horizon, or affected positions for which the rule was warranted.

The appropriate GRE response is therefore not to avoid comparison, but to preserve the boundary of the comparison. Partial commensurability should remain visible as partial.

24.10.2 Non-Commensurability

Non-commensurability should be stated with similar care. The failure of one metric does not prove that no meaningful comparison is possible. Monetary valuation can fail while ordinal priority, threshold rules, rights constraints, deliberative judgment, or qualitative comparison remains possible. Conversely, the existence of a ranking does not prove that the ranked values share a common measure. A decision-maker can choose one option over another because one crosses a minimum ecological threshold while the other does not, without claiming that ecological integrity has been converted into the same unit as financial return.

Definition 24.226 (Localized noncommensurability). A *localized noncommensurability* states the value forms involved, the comparison or conversion operation that fails, the reason for failure, the relevant domain and decision context, and the alternative forms of comparison that remain available or have also been ruled out.

This definition prevents the language of incommensurability from becoming too strong. Values can fail to admit cardinal conversion while remaining ordinally comparable. They can resist substitution while still admitting threshold comparison. They can be jointly discussed in practical reasoning while remaining irreducible to one scale.

Proposition 24.227 (Non-commensurability localization principle). *GRE should infer non-commensurability only for the operation whose failure has been established; stronger claims of general incomparability require additional argument concerning the other serious comparison procedures available in the inquiry.*

The converse limitation is also important. Researchers can understate non-commensurability by treating every choice as proof of comparison. A choice can arise through authority, habit, deadline, coercion, procedural default, budget constraint, or institutional hierarchy. The fact that action occurred does not establish that the values were rendered substantively commensurable.

Definition 24.228 (Decision without common measure). A *decision without common measure* is a practical selection among alternatives whose operative settlement does not depend on, and therefore does not establish, a common value measure or a substantively justified ordering of the heterogeneous claims at stake.

This distinction extends the settlement–resolution gap introduced in Section 24.9. Practical necessity can close action while leaving the evaluative structure open.

24.10.3 Local Commensuration

Many economic practices construct common measures that are useful precisely because they are local. Budgets, prices, scoring rules, rankings, cost-effectiveness thresholds, compensation formulas, multicriteria matrices, and negotiated exchange ratios can create decision spaces in which otherwise heterogeneous objects become comparable. GRE should study such commensuration as an institutional and relational achievement rather than assume that the common measure reveals an underlying natural equivalence.

Definition 24.229 (Local commensuration). *Local commensuration* is the bounded construction of a common comparison rule for heterogeneous value claims within a specified decision, institution, time horizon, or practical purpose, without presuming that the resulting comparability extends beyond that context.

A local commensuration can be legitimate and useful. Emergency triage may require priority criteria; public budgeting may require common fiscal constraints; organizational planning may require a common scoring procedure. The theoretical requirement is to distinguish the practical function of the common scale from claims about what the underlying values are.

Definition 24.230 (Commensuration scope record). *A commensuration scope record specifies the purpose of the common measure, the value forms admitted, the dimensions represented, the rule used, the decision-makers and affected positions, the period of validity, the excluded dimensions, and the conditions under which the commensuration should be reopened.*

Local commensuration can also become path dependent. Once data systems, funding rules, professional routines, legal standards, or performance indicators are organized around one common measure, subsequent decisions may reproduce the measure because alternatives are costly to express. The result can be mistaken for evidence that the measure is intrinsically appropriate.

Proposition 24.231 (Local commensuration non-identity). *The successful operation and repeated institutional use of a local commensuration rule do not by themselves establish that the values it compares are identical in kind, globally substitutable, or exhaustively represented by the common measure.*

Local commensuration is therefore best treated as a revisable interface. It can coordinate action while retaining the right to ask what its common scale has left out.

24.10.4 Institutional Commensuration

Institutional commensuration differs from merely local comparison because institutions can stabilize a comparison rule, allocate authority to it, and make it consequential for others. Currency, accounting systems, legal damages, standardized testing, insurance categories, credit ratings, procurement rules, and administrative scoring procedures can convert heterogeneous claims into institutionally actionable quantities or ranks. These forms of commensuration can become relationally real even when their evaluative justification remains contested.

Definition 24.232 (Institutional commensuration regime). *An institutional commensuration regime is a sufficiently stabilized set of rules, categories, representations, authorities, infrastructures, and enforcement or uptake mechanisms through which an institution renders heterogeneous claims comparable for recurring decisions.*

Institutional stabilization changes the problem in two ways. First, the measure can become performative. Actors adapt to ratings, categories, prices, compensation schedules, or eligibility scores, thereby increasing the measure's practical importance. Second, the institution can redistribute the burden of translation. Some groups must express their values in the authorized format while others control the format itself.

Definition 24.233 (Commensuration-authority profile). *A commensuration-authority profile records who defines the institutional comparison rule, who can revise it, who supplies the required representations, who bears losses created by omitted dimensions, which alternatives are recognized, and which actors can contest or exit the regime.*

The existence of such authority does not make institutional commensuration illegitimate. It makes the allocation of authority analytically relevant. An institution can

require a common measure because recurrent collective action would otherwise be impossible, but the common measure remains subject to evaluation in light of representation quality, participation, distribution, revision access, and residual value.

Proposition 24.234 (Institutional settlement non-validation). *The stability, legality, efficiency, or practical success of an institutional commensuration regime does not by itself validate the substantive value assumptions encoded in its comparison rule.*

This proposition is especially important where institutional metrics become self-confirming. High-stakes measures can shape behavior until the world increasingly resembles the categories used to assess it. GRE should then analyze both the descriptive quality of the commensuration and the relational reality produced by its institutional uptake.

24.10.5 Forced Commensuration

Some common measures are not merely local or institutional; they are imposed under conditions in which affected positions have little ability to reject the comparison frame. Forced commensuration can occur when a decision must be expressed in monetary terms despite non-monetary loss, when eligibility categories erase forms of need, when standardized rankings determine access despite contested criteria, or when a powerful actor defines which dimensions count as evidence. The central issue is not that a common measure exists, but that the terms of comparison are asymmetrically imposed and consequential alternatives are unavailable.

Definition 24.235 (Forced commensuration). *Forced commensuration* is a comparison arrangement in which heterogeneous value claims are required to enter an authorized common measure or ordering under conditions of materially asymmetric control over the rule, representation, exit, or revision of that comparison.

This definition keeps forced commensuration distinct from every mandatory institutional rule. Collective institutions often need binding procedures. The stronger diagnosis requires evidence about control and constrained alternatives, not merely dissatisfaction with the outcome.

Definition 24.236 (Forced-commensuration burden). *A forced-commensuration burden* is the value loss, representational distortion, strategic adaptation, exclusion, uncompensated remainder, or reduced revision capacity borne by an affected position because it must participate through a comparison rule it does not materially control.

Power analysis is therefore inseparable from forced commensuration. A common measure can relocate conflict from the visible decision to the prior question of which values can appear in the decision at all. Actors with greater resources may also be better able to translate their claims into the authorized metric, creating an inequality that appears after commensuration as if it were a neutral difference in score or price.

Proposition 24.237 (Power-sensitive commensuration condition). *Where control over a comparison rule, representation channel, or revision procedure is materially asymmetric, GRE should treat the resulting commensurability as partly constituted by power rather than as neutral evidence of pre-existing value equivalence.*

Forced commensuration can still yield necessary decisions. The analytical requirement is to preserve how the decision space was constituted and who bore the translation cost.

24.10.6 Translation without Common Measure

Heterogeneous values can sometimes be related without being measured in one unit. Translation can establish intelligible correspondence, practical implications, conditional dependencies, or mutually relevant constraints while preserving semantic difference. An ecological loss can be translated into implications for livelihood, institutional resilience, cultural practice, or future capability without asserting that these effects exhaust ecological value. A legal right can be translated into economic constraints and opportunities without converting the right itself into an economic quantity.

Definition 24.238 (Non-metric value translation). *Non-metric value translation* is a mapping between heterogeneous value descriptions that preserves specified relations, implications, or constraints without requiring a shared cardinal unit, exhaustive substitution rule, or claim of value identity.

Translation therefore has a different burden from commensuration. It must identify which semantic or causal relation is preserved and which aspects remain non-equivalent. A translation can be useful even when it is asymmetric: one domain may be able to express an implication of another without the reverse mapping preserving the same information.

Definition 24.239 (Translation-without-measure profile). A *translation-without-measure profile* records the source and target value descriptions, the relation preserved by translation, directionality, information loss, context dependence, non-equivalent dimensions, and the conclusions that may and may not travel through the mapping.

This profile connects directly to the cross-domain discipline of Chapter 23. Translation is strongest when it remains typed. Treating a translation as a conversion into one common value substance would erase the very heterogeneity that made translation necessary.

Proposition 24.240 (Translation non-equivalence principle). *A successful translation between heterogeneous value descriptions establishes the specified correspondence carried by the mapping; it does not by itself establish commensurability, substitutability, or equivalence of the translated values.*

Translation without common measure therefore enlarges the space of possible reasoning. GRE need not choose between scalar aggregation and complete silence. It can compare relations, consequences, thresholds, incompatibilities, and conversion conditions while retaining value heterogeneity.

24.10.7 Residual Value

Every bounded commensuration risks leaving something outside the common measure. The omitted dimension can be normatively minor, or it can be central to the affected position. GRE requires a vocabulary for what remains after comparison, translation, conversion, compensation, or settlement. *Residual value* names this remainder without assuming in advance that the remainder is intrinsically valuable, normatively overriding, or impossible to represent by some future method.

Definition 24.241 (Residual value). *Residual value* is a value-bearing dimension, claim, realization condition, affected position, or future possibility that remains materially relevant after a specified comparison, commensuration, translation, con-

version, compensation, or aggregation has been performed but is not adequately represented by that operation.

Residual value differs from simple measurement error. The remainder can arise because the common operation was intentionally narrow, because the relevant value lacks the required representation, because the comparison rule excludes certain bearers, or because the value relation is transformed when forced into the authorized metric.

Definition 24.242 (Residual-value ledger). A *residual-value ledger* records the operation that generated the remainder, the omitted or transformed value dimensions, affected positions, whether the remainder is recoverable or irreversible, whether it can be addressed by another procedure, and whether subsequent decisions depend on treating the remainder as negligible.

Residual value is particularly important for compensation. A financial payment can compensate some consequences of loss without restoring the relation, place, capability, option, ecological configuration, or institutional standing that was lost. The issue is not that compensation is meaningless; it is that compensation should not be redescribed as restoration unless the relevant value-bearing conditions are actually restored.

Proposition 24.243 (Compensation non-exhaustion condition). *Where a compensation rule represents only part of the value structure affected by a loss, successful payment or settlement should be interpreted as resolution of the represented claim rather than as evidence that the full value loss has been extinguished.*

A residual-value ledger can therefore preserve unresolved burdens after a decision has become final. This matters for historical learning because later research may reveal that what earlier procedures treated as negligible was structurally important.

24.10.8 Limits of Aggregation

Aggregation is attractive because it converts plural information into a form that can support ranking, optimization, budgeting, comparison, or monitoring. GRE does not reject aggregation. It asks what must be true for aggregation to preserve the distinctions relevant to the claim being made. The answer depends on the value forms, the distribution of gains and losses, thresholds, irreversibilities, temporal horizons, and the authority assigned to weights or trade-offs.

Definition 24.244 (Value-aggregation warrant). A *value-aggregation warrant* specifies the value forms included, the aggregation purpose, normalization and weighting rules, treatment of distribution and affected positions, temporal horizon, substitutability assumptions, thresholds or veto conditions, uncertainty, residual value, and the interpretation licensed for the aggregate result.

The same data can support different aggregates because weighting is not purely mechanical. Weights can encode empirical frequency, institutional priority, preference, political compromise, normative judgment, or convenience. GRE should therefore avoid presenting a weighted index as if the weighting scheme were merely discovered in the data when it contains substantive choices.

Definition 24.245 (Aggregation-loss profile). An *aggregation-loss profile* records which distinctions among value forms, bearers, distributions, thresholds, histories, and uncertainties disappear when a set of heterogeneous value claims is reduced to

an aggregate representation.

Some losses can be acceptable for the intended purpose. A dashboard may legitimately summarize many dimensions for monitoring while retaining disaggregated records for diagnosis. Other losses are disqualifying. Aggregation can conceal that one group bears an irreversible loss while another receives a compensating gain, that a minimum threshold is violated, or that one value is non-substitutable within the decision rule.

Proposition 24.246 (Aggregation adequacy condition). *An aggregate representation is adequate for a GRE claim only when the distinctions removed by aggregation are immaterial to that claim or are preserved through explicit constraints, disaggregation, thresholds, sensitivity analysis, or residual-value accounting.*

This condition yields a practical limit. Not every heterogeneous-value problem should culminate in a single index. In some inquiries, a partially ordered set of alternatives, a threshold structure, a vector of retained values, a portfolio of scenarios, or a documented unresolved conflict can be more informative than a scalar optimum. Formal simplicity should not be purchased by erasing the object of interest.

Definition 24.247 (Non-aggregable decision condition). *A non-aggregable decision condition obtains when every serious proposed aggregate would erase a distinction that is constitutive of the decision's evaluative, distributive, threshold, rights-based, irreversible, or historically specific structure, and no defensible correction preserves that distinction within the aggregate representation.*

Non-aggregability does not eliminate the need to act. It changes the appropriate decision architecture. Deliberation, sequencing, threshold rules, constrained optimization, multiple criteria, rights constraints, negotiated settlement, or explicit political judgment may still produce action. What GRE should resist is the retrospective claim that action proves the existence of a complete common value measure.

The limitation developed across this section can be summarized as follows. Heterogeneous value does not entail unrestricted incommensurability, and practical comparison does not entail value identity. Commensuration is often local, institutionally constructed, and sometimes power-laden. Translation can proceed without a common measure. Decisions can leave residual value, and aggregation can support analysis only when its losses remain compatible with the claim being made. GRE should therefore treat commensurability as an operation-relative and revisable achievement rather than as a universal property of value.

The next section turns from comparison to transformation. Even when values can be identified and compared adequately, GRE still faces open questions concerning when one value form can be converted into another; what is lost or gained at conversion interfaces, when conversion is irreversible or power-laden, and how conversion can be identified empirically without presuming equivalence.

24.11 Open Problems of Value Conversion

Sections 24.9 and 24.10 clarified the limits of value taxonomy, comparison, commensuration, and aggregation. The present section turns to a different difficulty: even when a source value form and a target value form can be described coherently, it can remain uncertain whether a genuine conversion process connects them. Its role in Chapter 24 is therefore to identify the unresolved conditions under which GRE

Table 24.11: Open problems in value-conversion analysis

Problem	Principal identification risk	Required GRE discipline
Conversion conditions	Source possession is confused with effective convertibility	Distinguish constitutive, enabling, complementary, threshold, and constraining conditions
Conversion interfaces	A complex transformation is attributed to an unspecified black box	Reconstruct the materially relevant interface functions and alternative pathways
Conversion loss	Any source–target difference is re-described as conversion loss	Attribute loss to the conversion mechanism and preserve heterogeneous remainders
Conversion gain	Target improvement is treated as proof that conversion generated the gain	Separate conversion-generated gain from transfer, redistribution, co-generation, and relabeling
Irreversibility	High reversal cost is confused with structural non-recoverability	Specify what cannot be recovered, by which reverse path, over what horizon, and why
Conversion failure	Heterogeneous unsuccessful episodes are pooled into one category	Localize failure to entry, interface, target realization, durability, or source–target specification
Conversion under power	Interface rules are treated as neutral technical conditions	Identify control over admission, terms, recognition, alternatives, appeal, and revision
Conversion without equivalence	Transformation is interpreted as common value substance	Preserve typed source and target forms and non-equivalent remainders
Empirical identification	Correlated source and target changes are treated as conversion	Require provenance, process evidence, rival-mechanism tests, and negative or contrastive evidence

can attribute value conversion rather than mere co-occurrence, transfer, circulation, reclassification, common-cause change, or parallel generation. The section examines conversion conditions, interfaces, loss and gain, irreversibility, failure, power, non-equivalent conversion, and empirical identification. The method is mechanism-oriented and explicitly comparative. A conversion claim should become stronger only when the proposed source–target transformation survives serious rival explanations and when the interface through which the transformation occurs is sufficiently reconstructed for the research question at hand.

The underlying difficulty is structural. GRE defines conversion as a typed transformation in which a value-bearing condition represented in one form, register, or domain becomes realizable, legible, actionable, or institutionally effective in another. The definition is intentionally broader than monetary exchange and intentionally weaker than value equivalence. That breadth creates analytical reach, but it also creates a risk of conceptual over-attribution. If every change in practical significance is called conversion, the concept loses its capacity to discriminate among mechanisms. The open problem is therefore not merely how to describe more kinds of conversion, but how to determine when conversion is the best-supported explanation of an observed transformation.

Table 24.11 summarizes the limitation architecture developed in this section.

24.11.1 Conversion Conditions

A source value form is not automatically convertible into a target form. Knowledge does not become recognized qualification solely because knowledge exists; financial resources do not become health capability without access, infrastructure, time, information, and suitable services; ecological significance does not become legally protected status without relevant institutions; and social recognition does not become enforceable entitlement merely because it is widely expressed. Conversion therefore depends on a condition architecture rather than on a source quantity alone.

Definition 24.248 (Conversion-condition architecture). A *conversion-condition architecture* records the conditions that materially determine whether a specified source value form can become effective in a specified target form through a specified interface, distinguishing at least constitutive, enabling, complementary, threshold, constraining, temporal, and position-specific conditions where those distinctions affect the explanation.

The distinction among condition types matters. A constitutive condition helps define what the conversion is; an enabling condition makes an otherwise defined conversion practically possible; a complementary condition must be combined with the source; a threshold condition determines admissibility or activation; and a constraining condition narrows the domain, rate, timing, or target form. The same empirical feature can occupy different roles in different conversion architectures. Legal status can be constitutive of one institutional conversion, merely enabling in another, and irrelevant in a third.

Proposition 24.249 (Conditional convertibility principle). *GRE should attribute convertibility to a source position only relative to a specified target, interface, and materially relevant condition architecture; possession of the source form alone does not establish effective conversion capacity.*

An additional open problem arises because conversion conditions can themselves be historically generated by earlier conversions. A credential can become a condition for employment because prior institutional processes established credentialing as a recognized interface. Financial collateral can become a condition for credit because legal and organizational arrangements stabilize the relevant recognition regime. Conversion analysis can therefore become recursively historical: the conditions that explain a present conversion may be outputs of earlier conversion and institutionalization processes.

Definition 24.250 (Endogenous conversion condition). An *endogenous conversion condition* is a materially relevant condition of a conversion process whose availability, meaning, or distribution is itself produced or transformed by the relational system under analysis.

Endogeneity does not make analysis impossible, but it limits static interpretation. A condition profile should state whether the relevant conditions are being treated as fixed for the local inquiry or whether their generation is part of the mechanism that must be explained.

24.11.2 Conversion Interfaces

Conversion interfaces are the arrangements through which a typed transformation becomes possible. Earlier chapters treated markets, courts, credentialing systems, platforms, banks, standards, schools, organizational routines, translation practices, ecological processes, and interpersonal relations as possible interfaces. The open problem is that an interface can become an explanatory black box if the analysis names the institution without reconstructing the function through which source significance becomes target effectiveness.

Definition 24.251 (Conversion-interface reconstruction). A *conversion-interface reconstruction* identifies the materially relevant functions through which an interface changes the feasibility, form, recognition, timing, burden, or durability of a specified source–target transformation, together with the actors, rules, technologies, represen-

tations, and complementary conditions through which those functions operate.

Interface reconstruction should remain proportional to the claim. A narrow administrative question may require only an eligibility rule and processing sequence. A claim about persistent dependence may require a richer reconstruction of gatekeeping, classification, appeals, alternative pathways, technical interoperability, pricing, and historical rule formation.

A second difficulty is *interface multiplicity*. Several distinct interfaces may connect the same source and target. Knowledge can become occupational eligibility through formal degrees, professional examinations, portfolios, apprenticeship, prior work, or employer-specific assessment. If one pathway is studied in isolation, the analysis can mistakenly attribute necessity to an institution that is merely one historically dominant route.

Definition 24.252 (Interface-necessity burden). The *interface-necessity burden* is the evidential requirement for claiming that a specified interface, rather than one of several feasible alternatives, is necessary or uniquely explanatory for the target conversion within the defined domain and period.

The converse problem also occurs. An apparently singular interface may actually compose several nested interfaces. A financing decision can involve legal identity, credit scoring, collateral recognition, risk classification, pricing, documentation, and settlement infrastructure. An observed conversion outcome can therefore depend on a sequence of filters rather than one point of passage.

Definition 24.253 (Composite conversion interface). A *composite conversion interface* is a conversion architecture in which successful target realization depends on two or more materially distinct interface stages whose ordering, interaction, or cumulative burdens affect conversion feasibility or incidence.

GRE should decompose a composite interface when different stages support different causal, distributive, or power claims. Otherwise the language of an interface can conceal the very mechanism the concept was introduced to identify.

24.11.3 Conversion Loss

Conversion loss is analytically meaningful only when the loss can be attributed to the conversion process or to conditions inseparable from its operative architecture. A difference between source and target is not by itself evidence of loss. Some dimensions can simply be irrelevant to the target, preserved outside it, or transformed into a different manifestation. Other losses may arise from background deterioration, transfer to another position, measurement compression, or an independent contemporaneous process.

Definition 24.254 (Conversion-loss attribution). A *conversion-loss attribution* identifies a source-side or relational dimension that becomes destroyed, inaccessible, weakened, excluded, transferred, or materially harder to recover through the specified conversion process, and distinguishes that mechanism from serious alternative explanations of the observed loss.

This definition strengthens the earlier idea of a conversion remainder. A remainder records what does not survive or become represented in the target; a loss attribution adds the stronger claim that the conversion mechanism materially contributed to that disappearance or degradation. The distinction matters because not every remainder

is harmful and not every harm is conversion-induced.

Definition 24.255 (Conversion-loss incidence profile). A *conversion-loss incidence profile* records which value-bearing dimensions are lost or weakened, which positions bear the loss, when the loss occurs, whether the loss is recoverable, and whether another position captures or retains what the affected position loses.

The last element prevents dissipation, redistribution, and capture from being collapsed. If a community loses control over a resource because another actor acquires control, the process is not adequately described as mere disappearance. If a standardized representation omits tacit knowledge while the original practice remains viable elsewhere, representational loss need not equal destruction of the source practice. If ecosystem degradation finances a target-side gain, ecological loss and financial gain should remain separately traced rather than netted into one scalar without further warrant.

Proposition 24.256 (Loss non-netting condition). *Where conversion loss and conversion gain concern heterogeneous value forms, different affected positions, or different temporal horizons, GRE should record them separately unless an independently warranted comparison rule justifies aggregation for the specific claim.*

24.11.4 Conversion Gain

Conversion gain presents the mirror-image attribution problem. A target-side improvement can follow a conversion episode without being generated by the conversion mechanism. The target may improve because complementary resources were introduced at the same time, because a third process generated the outcome, because value was transferred from another position, or because the target was reclassified rather than substantively changed.

Definition 24.257 (Conversion-gain attribution). A *conversion-gain attribution* identifies a target-side value-bearing capacity, right, option, recognition, relation, or other economically significant condition whose realization or amplification is materially explained by the specified conversion process after serious alternative sources of the gain have been considered.

Conversion gain therefore differs from conversion success. A successful conversion establishes that the specified target condition has been realized to the relevant threshold. A conversion-gain claim additionally asserts that some target-side value increased or emerged through the process. A legal recognition can successfully convert a claim into enforceable status without producing the broader social or economic gains expected from that recognition. Conversely, an unsuccessful formal conversion can sometimes stimulate learning or organization that generates value through another pathway.

Definition 24.258 (Target-side co-generation). *Target-side co-generation* occurs when the target outcome attributed to conversion is jointly produced by the conversion process and one or more complementary generative mechanisms whose contribution is analytically material.

Co-generation is likely to be common rather than exceptional. Education can convert learning into credentials while peer relations, mentoring, institutional reputation, and labor-market conditions jointly generate the eventual employment outcome. A research publication can convert inquiry into recognized scholarly output while

networks, journal prestige, language, timing, and institutional affiliation affect later opportunities. Conversion analysis should therefore resist both extremes: denying conversion because multiple causes are present, and attributing the entire target gain to conversion simply because conversion is one necessary step.

Proposition 24.259 (Gain decomposition principle). *Where target-side gain is plausibly co-generated, GRE should distinguish the contribution of the conversion process from complementary generation, redistribution, background change, and representational reclassification to the degree required by the research question.*

24.11.5 Irreversibility

Irreversibility is especially vulnerable to overstatement. A conversion can be difficult, costly, slow, institutionally blocked, or politically unlikely to reverse without being structurally irreversible. Conversely, an apparent technical reversal can fail to restore lost relations, options, ecological conditions, rights, or historical position. GRE therefore needs a typed account of what reversal would mean.

Definition 24.260 (Conversion-reversal specification). *A conversion-reversal specification states the source dimensions expected to be recovered, the proposed reverse interface, the required conditions, the temporal horizon, the acceptable reconstruction tolerance, and the dimensions that are not expected to return even if the target is converted into a source-like form.*

This specification distinguishes several forms of irreversibility. *Material irreversibility* concerns physical or ecological states that cannot be practically reconstructed. *Institutional irreversibility* concerns rights, classifications, commitments, or infrastructures whose reversal is blocked or substantially path-dependent. *Relational irreversibility* concerns trust, membership, reputation, dependence, or other relations that are not restored merely by reversing the nominal transaction. *Option irreversibility* concerns foreclosed alternatives. *Historical irreversibility* concerns the simple fact that the original temporal position cannot be recreated after the sequence has occurred.

Definition 24.261 (Conversion irreversibility profile). *A conversion irreversibility profile identifies which dimensions of a conversion episode are non-recoverable, costly to recover, delayed, path-dependent, or reconstructable only approximately, and states the evidence supporting each classification.*

The profile avoids a binary reversible-irreversible label where different dimensions behave differently. Financial compensation may reverse a monetary transfer while leaving ecological damage, lost time, disrupted identity, or institutional dependence substantially unrecovered. A reverse credentialing process may revoke formal status without restoring the opportunity set that existed before the original credential altered a career path.

Proposition 24.262 (Irreversibility localization principle). *A conversion should be described as irreversible only with respect to the dimensions, reverse pathway, reconstruction tolerance, and horizon for which non-recoverability has been established; practical difficulty alone does not justify a stronger claim.*

24.11.6 Conversion Failure

Failed conversion is informative only when failure is localized. An unsuccessful episode can fail before entry, at validation, during transformation, at target realization, after nominal realization, or during persistence. These failures imply different mechanisms and different interventions.

Definition 24.263 (Conversion-failure locality). *Conversion-failure locality* identifies the stage at which a specified conversion attempt ceases to satisfy the conditions required for target realization, distinguishing at least source admissibility, interface access, validation, transformation, target realization, target durability, and later usability where those stages are analytically material.

A failed university application and a degree that does not produce occupational recognition are both unsuccessful conversion episodes in a broad sense, but they fail at different interfaces and target conditions. A benefit may be formally awarded while inaccessible in practice. A platform may approve monetization while actual revenue remains negligible. These cases justify preserving the distinction between formal completion and substantive target realization.

Definition 24.264 (Durability failure). *A durability failure* occurs when the target condition is initially realized but cannot be sustained for the period, use, or relational function specified by the research question because the conversion architecture does not reproduce the conditions required for persistence.

Failure can also challenge the source–target specification itself. Repeated failures across otherwise favorable condition sets may indicate that the proposed source is not actually convertible into the stated target, that the interface has been misidentified, or that the target category bundles several different outcomes.

Definition 24.265 (Conversion-model falsification pressure). *Conversion-model falsification pressure* is the cumulative evidential pressure produced when well-specified conversion attempts repeatedly fail under conditions that the current conversion model treats as sufficient or strongly enabling.

Such pressure should revise the model rather than being absorbed indefinitely as unexplained friction. Negative cases are especially valuable when the theory would otherwise be able to classify every outcome as a conditional conversion.

24.11.7 Conversion under Power

Conversion interfaces frequently distribute authority as well as technical functionality. A gatekeeper can determine admissible sources, acceptable evidence, recognition categories, prices, timing, interoperability, appeal procedures, and which alternatives remain available. Power therefore enters value conversion not only after value has been produced, but in the constitution of what can become convertible in the first place.

Definition 24.266 (Conversion-regime power profile). *A conversion-regime power profile* records the positions able to alter admission, classification, validation, terms, timing, burden, target recognition, alternative pathways, appeals, and rule revision within a specified conversion architecture, together with the dependencies and exit options of affected positions.

The profile extends earlier conversion-power analysis by treating the conversion regime itself as historically revisable. Control over a present interface can alter fu-

ture convertibility by changing categories, standards, infrastructure, or institutional expectations. A platform can modify monetization rules; a professional body can redefine valid credentials; a state can change the conditions under which claims receive legal recognition. The exercise of conversion power can therefore alter the future source–target map rather than merely select outcomes within a fixed map.

Definition 24.267 (Conversion-rule endogeneity). *Conversion-rule endogeneity* exists when actors materially affected by or exercising power within a conversion regime can alter the rules, categories, technologies, or institutional conditions that define subsequent convertibility.

Power analysis should nevertheless remain discriminating. Differential conversion outcomes do not by themselves establish power. Differences can arise from capacity, timing, complementary resources, legal constraints, or heterogeneous source conditions. A power claim requires evidence that one position can materially affect another position's conversion possibilities or terms in a way that is not reducible to mere difference.

Proposition 24.268 (Power-sensitive conversion condition). *GRE should attribute conversion power when a position can materially alter another position's conversion feasibility, terms, timing, recognition, burden, or alternatives through control or influence over a conversion interface or condition, and when serious non-power explanations of the observed asymmetry have been considered.*

The normative assessment of such power remains separate. Some gatekeeping is necessary for safety, verification, coordination, or rights protection. Whether a particular conversion regime is legitimate, exploitative, unjust, or appropriate requires additional normative and domain-specific warrant.

24.11.8 Conversion without Equivalence

Value conversion does not require source and target to share a common metric, substance, or evaluative standing. This feature gives the concept much of its usefulness, because economically important transformations frequently connect heterogeneous forms. It also creates one of its largest interpretive risks. Once a conversion pathway is observed, analysts can begin to speak as though the source and target are substitutable representations of the same underlying quantity.

Definition 24.269 (Non-equivalent conversion). A *non-equivalent conversion* is a supported source–target transformation in which conversion is practically or institutionally real while source and target remain non-identical in constitutive conditions, evaluative meaning, realization, affected positions, temporal structure, or other dimensions material to the inquiry.

A payment can convert recognized liability into financial settlement without restoring damaged trust. Compensation can convert a legally recognized harm into a monetary remedy without making the harm and payment equivalent value forms. A credential can convert demonstrated learning into institutional eligibility without making learning and credential status interchangeable. Ecological conditions can become legally protected classifications without the legal status exhausting ecological value.

Definition 24.270 (Non-equivalence remainder). A *conversion non-equivalence remainder* records the source-side and target-side dimensions that remain materially non-identical despite successful conversion, including meanings, rights, relations, ca-

pacities, temporal properties, affected positions, or normative claims that are not preserved by the transformation.

This remainder connects conversion analysis to the residual-value architecture developed in Section 24.10. Successful conversion can solve a practical problem while leaving uncompensated, untranslated, or non-substitutable dimensions. The relevant discipline is to state what the conversion accomplishes without extending that accomplishment into a stronger equivalence claim.

Proposition 24.271 (Conversion non-equivalence principle). *Evidence that a conversion process reliably connects a source value form to a target value form does not by itself establish commensurability, substitutability, compensation adequacy, reversibility, or normative equivalence between the source and target.*

24.11.9 Empirical Identification

Empirical identification is the deepest open problem of value conversion because the concept concerns a mechanism, not a pattern of covariance. If a source indicator rises before a target indicator rises, several explanations remain possible. The source may have been converted into the target; both may respond to a common cause; the target may have been generated independently; a third value form may have been transferred; the source and target may be two manifestations of one underlying change; classification rules may have changed; or the measured association may be spurious. Temporal order alone does not discriminate among these possibilities.

Definition 24.272 (Conversion-identification dossier). A *conversion-identification dossier* records the proposed source and target value forms, the conversion episode, interface, condition architecture, temporal sequence, affected positions, process evidence, expected intermediate changes, serious rival mechanisms, negative or contrastive cases, and the observations that would weaken or revise the conversion attribution.

The dossier is method-neutral. Process tracing can reconstruct institutional or relational sequences; qualitative evidence can reveal tacit conditions and actor interpretations; experiments or quasi-experiments can estimate consequences of interface or rule changes; longitudinal data can test temporal ordering and persistence; administrative records can identify admission and failure stages; comparative cases can reveal alternative interfaces; and formal models can organize mechanism hypotheses. No single method is automatically privileged. The appropriate evidential combination depends on what the conversion claim asserts.

A useful way to discipline empirical claims is to distinguish levels of identification rather than treating conversion as either observed or unobserved.

Definition 24.273 (Conversion-identification ladder). A *conversion-identification ladder* orders conversion evidence from weak to stronger warrant according to whether research establishes: source–target association; temporal ordering; interface exposure; intermediate process evidence; condition-sensitive outcome differences; discrimination against serious rival mechanisms; and replicated or contrastive evidence across relevant episodes or regimes.

The ladder is not a universal scoring rule. Some mechanisms leave rich process traces but little quantitative variation; others permit strong quasi-experimental comparison while remaining partly opaque internally. Its purpose is to prevent a weak

association from being described with the same confidence as a well-traced and contrastively supported conversion mechanism.

Several rival explanations deserve explicit preservation.

Definition 24.274 (Conversion-rival set). A *conversion-rival set* is the set of serious alternative mechanisms capable of producing the observed source–target pattern without the proposed conversion mechanism, including where relevant common-cause change, co-generation, transfer, circulation, reclassification, simultaneous manifestation, measurement substitution, target-side generation, and selection into the interface.

The rival set should be proportional rather than exhaustive. The objective is not to enumerate every logically imaginable explanation, but to retain the alternatives that would materially change the interpretation or intervention if true.

Proposition 24.275 (Conversion-identification condition). A *GRE conversion claim* acquires stronger empirical warrant when the source and target are independently typed, a materially relevant interface and condition architecture are reconstructed, predicted intermediate changes are observed where accessible, serious rival mechanisms are weakened by process, comparative, or intervention evidence, and failed or negative cases remain capable of revising the source–target model.

This condition deliberately avoids requiring one universal causal design. Historical, legal, ecological, organizational, educational, technological, and market conversions differ in observability and manipulability. What should remain constant is the demand that the conversion mechanism do explanatory work beyond redescribing correlated change.

Definition 24.276 (Conversion attribution ceiling). A *conversion attribution ceiling* is the strongest conversion claim warranted by the available provenance, interface reconstruction, condition evidence, rival-mechanism discrimination, and negative evidence in a specified inquiry.

The attribution ceiling provides a practical stopping rule for epistemic humility. Evidence may justify saying that a conversion pathway is plausible, that an interface materially contributes to conversion, that a conversion mechanism is strongly supported in one regime, or that a specified source is reliably convertible under stated conditions. It may not justify a universal source–target law, a scalar conversion rate, or a claim that the same mechanism operates across domains.

Proposition 24.277 (Conversion open-problem principle). *Value conversion should remain an open empirical and theoretical research object whenever the source–target transformation, interface, conditions, loss, gain, reversibility, failure structure, power relations, or rival mechanisms remain materially underdetermined; uncertainty in those dimensions should narrow the conversion claim rather than be absorbed into an unrestricted conversion vocabulary.*

The section therefore leaves value conversion neither as a metaphor nor as a completed formal object. Its usefulness depends on a disciplined distinction among transformation, transfer, circulation, generation, representation, and institutional recognition, together with empirical procedures capable of deciding which mechanism is operative in a particular case. The next section turns to the open problem of value circulation: even where value has been generated or converted, how can its subsequent circulation, dissipation, capture, return, regeneration, and cross-form transmission be traced without presuming scalar conservation or homogeneous flow?

24.12 Open Problems of Value Circulation

Section 24.11 treated value conversion as an identification problem: a source–target association does not establish a conversion mechanism, and even a well-supported conversion does not establish equivalence between the value forms involved. The present section addresses the next open problem in the value-process architecture. Once value-bearing conditions have been generated, transferred, transmitted, converted, or recognized, their later movement through economic and institutional relations can remain difficult to reconstruct. The role of this section is therefore to examine the limits of attributing *circulation*: which paths are materially part of the circulation process, how circulation crosses domains and scales, how delays and repeated re-entry alter the path, where dissipation or capture occurs, when circulation contributes to regeneration, and how transmission can be formalized without presuming a conserved scalar. The method is provenance-preserving and mechanism-oriented. A circulation claim should identify the value-bearing condition, the path through which it becomes consequential, the transformations and losses occurring along that path, the affected positions, and the evidential limits on reconstructing the complete circulation architecture.

The main difficulty is that circulation is neither a synonym for transfer nor a claim that one unchanged object travels around a closed loop. Earlier chapters defined economic circulation as a temporally extended configuration of linked transfers that can include transformation, delay, return, accumulation, dissipation, capture, or regeneration. That broad definition is useful because it includes money, rights, knowledge, capability, recognition, institutional authority, ecological conditions, and other heterogeneous value-bearing forms. Its breadth also creates an open identification problem. A researcher can too easily infer a circulation process from repeated observations of similar value manifestations, from aggregate flows whose internal paths are unknown, or from a return event whose provenance has not been reconstructed. The task in this section is therefore to make circulation analytically demanding enough to remain discriminating.

Table 24.12 summarizes the limitation architecture developed below.

24.12.1 Circulation Path Architecture

A circulation claim concerns a path rather than a pair of endpoints. The endpoints can be important, but they are insufficient when intermediaries transform what passes through them, when several routes coexist, when path selection depends on institutional rules, or when downstream effects reach positions not represented in the initial transfer. A remittance, for example, can move through employers, payment systems, currency conversion, banking rules, household allocation, debt relations, and local markets before its longer-term effects become visible. A research finding can circulate through publication, translation, standards, training, organizational adoption, and policy. The same nominal source and final recipient can therefore be connected by materially different circulation architectures.

Definition 24.278 (Circulation-path reconstruction). A *circulation-path reconstruction* is a bounded account of the materially relevant sequence of positions, intermediaries, relations, transfer events, transformations, delays, and affected parties through which a specified value-bearing condition becomes consequential beyond its initial

Table 24.12: Open problems in value-circulation analysis

Problem	Principal identification risk	Required GRE discipline
Path reconstruction	Aggregate movement is treated as a known relational path	Preserve provenance, intermediaries, path alternatives, transformations, and affected positions
Cross-domain circulation	Passage between domains is treated as semantic continuity	Re-type the value form and retain domain-specific warrants and remainders
Cross-scale circulation	Aggregation is confused with movement between scales	Specify mediation, incidence, aggregation rules, and feedback across levels
Delay	Later effects are attributed directly to an earlier source	State latency, intervening conditions, rival sources, and temporal uncertainty
Recirculation	Any recurrence is interpreted as return to generation	Identify the prior episode, re-entry pathway, and later generative condition
Dissipation	Reduced observability or realization is equated with value destruction	Distinguish attenuation, decay, diversion, transformation, and measurement loss
Capture	Unequal receipt is treated as appropriation	Identify control over routing, retention, redirection, or realization and its counterfactual relevance
Regeneration	Repeated circulation is assumed to reproduce its enabling conditions	Establish the mechanism through which circulation restores or expands later capacity
Non-conservation	Flow language silently imports a conserved scalar	Permit replication, amplification, depletion, transformation, and heterogeneous remainder
Formal transmission	Mathematical paths are treated as self-interpreting	Define nodes, edges, events, types, composition rules, and empirical semantics locally
Heterogeneous transfer	Similar manifestations are treated as the same moving value	Preserve source and target forms, conversion steps, and non-equivalence remainders
Justice	Descriptive path asymmetry is converted directly into a normative verdict	Separate incidence and control evidence from the normative framework used for evaluation

location over a stated horizon.

The reconstruction is necessarily purpose-relative. A payment-settlement inquiry may not require the later household use of the funds, while a capability inquiry may need to trace whether the payment actually became housing stability, education, health access, debt reduction, or another condition. Path completeness is therefore not an absolute demand. What matters is whether omitted segments could reverse, substantially weaken, or retype the claim being made.

Definition 24.279 (Circulation-path adequacy). *Circulation-path adequacy* is the degree to which a reconstructed path contains the segments, transformations, intermediaries, and affected positions needed to support the specific circulation claim while making materially relevant omissions explicit.

Circulation paths can branch and merge. One source can produce several downstream consequences, while several sources can converge on one later condition. This makes simple source attribution difficult. A scholarship may contribute to capability, credentials, professional networks, household finances, and later knowledge production. Conversely, later occupational capability can reflect education, prior experience, health, social support, legal status, and organizational learning. GRE should therefore avoid reading a path diagram as a proof that every downstream state is attributable to one upstream source.

Proposition 24.280 (Path non-exclusivity principle). *Evidence for a materially relevant circulation path from one source does not by itself establish that the source is necessary, sufficient, or exclusive for the later value-bearing condition when alternative, convergent, or branching paths remain serious possibilities.*

The open problem is consequently not to produce maximally large path maps, but to identify the smallest path architecture that preserves the mechanisms material to the claim and the strongest rival paths that could change its interpretation.

24.12.2 Cross-Domain Circulation

Value-bearing conditions can become consequential across disciplinary and institutional domains. Scientific knowledge can become educational content, organizational capability, legal evidence, technical standards, political authority, or commercial advantage. Ecological conditions can become legal restrictions, financial risks, political claims, or community capabilities. Social recognition can become institutional access, reputational advantage, or exclusion. These movements can be economically consequential, but cross-domain circulation should not be represented as if one stable value substance simply crossed a boundary.

Definition 24.281 (Cross-domain circulation episode). A *cross-domain circulation episode* is a circulation segment in which a value-bearing condition becomes effective within a domain whose constitutive categories, evidential warrants, institutional rules, or evaluative semantics differ materially from those governing the preceding segment.

The definition makes cross-domain circulation dependent on retyping. A scientific result does not become legal validity merely by entering a courtroom. A community value does not become market value merely because a price is assigned. An ecological state does not become political legitimacy because it becomes salient in public debate. A domain interface can transmit evidence, recognition, constraint, capability, or a converted representation while leaving significant semantic and normative remainders.

Definition 24.282 (Domain-transition remainder). A *domain-transition remainder* records the materially relevant properties, warrants, meanings, affected positions, or normative claims that are not preserved when a value-bearing condition becomes effective across a domain boundary.

The domain-transition remainder prevents the path from being narrated as semantic continuity. It also connects the present section to the book's preceding cross-domain analysis, where neighboring domains retained independent correction authority. If the legal, ecological, educational, social, political, or aesthetic premise changes, the economic interpretation of the cross-domain circulation may also require revision.

Proposition 24.283 (Cross-domain retyping condition). A *GRE claim about cross-domain circulation* should identify the domain transition, the representation or mechanism through which the transition occurs, the value form operative on each side, and any domain-specific remainder material to the economic conclusion; repeated use of one label across domains does not establish continuity of value semantics.

Cross-domain circulation can therefore be real without being homogeneous. The path is reconstructed through a sequence of domain-specific realizations, translations, and conversions rather than through an assumed universal value carrier.

24.12.3 Cross-Scale Circulation

Scale introduces a different problem. A value-bearing effect can move among individual, household, organizational, community, regional, national, transnational, infrastructural, or ecological configurations. Yet movement between scales is not equivalent to aggregation. Individual learning can contribute to organizational capability, but organizational capability is not simply the sum of individual learning. Local tax

bases can support national revenue, which can later finance local infrastructure, but the aggregation, allocation, and return stages are governed by institutions that alter incidence. Local ecological degradation can accumulate into wider system effects, while wider regulation can change local incentives and constraints.

Definition 24.284 (Cross-scale circulation architecture). A *cross-scale circulation architecture* records the mechanisms by which a value-bearing condition, consequence, representation, or constraint becomes consequential across differently constituted analytical scales, including the aggregation, disaggregation, mediation, translation, and feedback processes through which the scale transition occurs.

Cross-scale claims therefore need more than a change in the unit of observation. They should specify whether the relevant mechanism is aggregation, institutional pooling, distributed coordination, network propagation, hierarchical delegation, ecological coupling, shared infrastructure, or another process. Otherwise an apparent movement from micro to macro or macro to micro can be an artifact of measurement rather than a circulation mechanism.

Definition 24.285 (Scale-transition incidence profile). A *scale-transition incidence profile* records which positions contribute to, mediate, receive, benefit from, bear burdens from, or remain excluded by a cross-scale circulation process, together with the rules through which scale-level effects are distributed back to differently situated positions.

The incidence profile is needed because aggregate return can conceal local non-return. A region can contribute labor, data, ecological capacity, or tax revenue to a wider system while receiving little later capability or institutional investment. Conversely, a wider system can subsidize local resilience without a proportional local contribution. Neither pattern is evaluatively settled by the circulation description alone, but both change the distributional and power questions that later analysis must address.

Proposition 24.286 (Cross-scale non-aggregation principle). A *change observed at one analytical scale should not be attributed to cross-scale value circulation solely because related changes appear at another scale; the claim requires a materially relevant mediation, aggregation, disaggregation, or feedback mechanism connecting the scales.*

24.12.4 Temporal Delay in Circulation

Circulation can be delayed at several points. Institutions can hold resources before allocating them. Knowledge can remain unused until complementary technology appears. Education can affect capability years after instruction. Ecological restoration can require long periods before downstream conditions change. A legal recognition can remain formally valid while practical realization waits for administrative implementation. Delay therefore changes both attribution and evaluation.

Definition 24.287 (Circulation latency). *Circulation latency* is the temporally consequential interval between a specified transmission, transfer, conversion, or propagation event and the later stage at which the relevant value-bearing effect becomes materially realized, redirected, returned, or observable.

Latency is not a residual time lag. It can have mechanisms: maturation, institutional processing, waiting, accumulation, learning, infrastructure construction, ecological regeneration, strategic withholding, or coordination delay. The mechanism

matters because it determines whether the delay should be treated as ordinary maturation, avoidable friction, gatekeeping, risk management, or another process.

Definition 24.288 (Delay-attribution window). A *delay-attribution window* is the historically and mechanism-specific interval within which an earlier circulation event remains a serious explanatory contributor to a later value-bearing condition, given intervening events, competing sources, decay, transformation, and uncertainty.

The attribution window guards against two opposite errors. A window that is too short misses long-horizon transmission and generative return. A window that is too long makes nearly any later effect attributable to an earlier event. The appropriate horizon depends on the mechanism and the evidence, not on a universal temporal rule.

Proposition 24.289 (Delayed-circulation attribution condition). *The longer the temporal separation between a proposed circulation source and a later realization, the more the claim should preserve intervening conditions, rival sources, path discontinuities, decay or transformation, and evidence capable of weakening the attribution.*

Delay can also alter incidence. A policy may impose present burdens while producing later benefits for different positions. An ecological intervention can benefit future populations that did not bear its present cost. A delayed circulation analysis should therefore preserve temporal distribution rather than discounting every position into one contemporaneous account without independent justification.

24.12.5 Recirculation and Re-entry

Recirculation concerns re-entry into later generative conditions. It is therefore more demanding than recurrence. A payment can recur monthly without altering or re-entering the conditions that produce later value. By contrast, revenue used to maintain productive infrastructure, knowledge returned to a community as usable capacity, or institutional learning incorporated into later decision procedures can form a genuine recirculatory path.

Definition 24.290 (Recirculation dossier). A *recirculation-identification dossier* records the earlier value-bearing episode, the condition that persists or is transformed, the return or redirection pathway, the later generative configuration into which it re-enters, the affected positions, the temporal separation, and the evidence linking the earlier episode to the later generative role.

The dossier distinguishes recirculation from repetition, repayment, replacement, and ordinary redistribution. A replacement input can maintain production without being derived from an earlier output. A repayment can close a liability without strengthening later generation. A recurring subsidy can support a system while leaving the system dependent on external inflow. Recirculation becomes analytically distinctive when earlier outputs or consequences become inputs, capacities, institutions, relations, knowledge, options, or ecological conditions that materially shape later generation.

Definition 24.291 (Recirculatory transformation). A *recirculatory transformation* occurs when re-entry changes the relations, capabilities, rules, infrastructures, technologies, evaluative practices, or option structures through which subsequent circulation or generation takes place.

Recirculation can therefore be self-modifying. A platform reinvests revenue into

infrastructure that changes future ranking and access; a public programme converts lessons into revised eligibility rules; a community return creates a new institution; ecological regeneration alters future production constraints. The later cycle is not simply another iteration of the first.

Proposition 24.292 (Recirculation non-self-sufficiency principle). *Evidence for a re-circulatory path does not by itself establish that the relevant system is self-sustaining, regenerative, independent of external support, or normatively desirable; those stronger claims require separate evidence concerning maintenance, external inputs, burdens, capture, and later system transformation.*

24.12.6 Dissipation in Circulation

Circulation can weaken, decay, or cease before a value-bearing condition reaches a later position. Yet the word *dissipation* can become misleading if every reduction between an upstream and downstream manifestation is called loss. Some reductions reflect legitimate use, conversion, allocation, depreciation, transformation into an unmeasured form, or a change in the relevant comparison boundary. The open problem is to identify when the circulation process itself materially reduces the later availability or effectiveness of the value-bearing condition.

Definition 24.293 (Circulation dissipation). *Circulation dissipation* is a process-specific reduction in the persistence, availability, usability, realizability, or generative capacity of a specified value-bearing condition along a circulation path that cannot be explained adequately as intended transfer, supported conversion, ordinary realization, or mere representational change within the stated inquiry.

Dissipation mechanisms can include physical decay, maintenance failure, information degradation, skill attrition, trust erosion, transaction burden, exclusion, failed interoperability, institutional delay, or ecological depletion. Different mechanisms require different evidence. A financial fee is observable retention by an intermediary rather than dissipation in the same sense as deteriorating knowledge quality or decaying infrastructure. The categories should therefore remain typed.

Definition 24.294 (Dissipation-location profile). *A dissipation-location profile* identifies the circulation segment at which a value-bearing condition becomes materially less persistent, available, usable, realizable, or generative, together with the proposed mechanism, affected positions, alternative explanations, and evidential uncertainty.

An important empirical complication is unobserved transformation. What appears to disappear at one register can reappear in another. Financial resources spent on maintenance no longer appear as cash but can persist as infrastructure function. Time devoted to training leaves the time budget but may become capability. The possibility of conversion does not eliminate dissipation, but it means that dissipation claims need cross-form checks where the missing value could plausibly have been transformed rather than destroyed.

Proposition 24.295 (Dissipation attribution condition). *A GRE claim of circulation dissipation should distinguish reduction in the focal value form from transformation into another form and should identify the path segment and mechanism responsible before interpreting an upstream–downstream difference as value loss.*

24.12.7 Capture along Circulation Paths

Capture concerns redirection or appropriation along a circulation path. Unequal receipt alone is insufficient. A circulation architecture can be intentionally redistributive, can compensate intermediaries for genuine functions, or can produce unequal outcomes without any position exercising material control over routing. A stronger capture diagnosis requires evidence concerning control over the path and the counterfactual consequences of that control.

Definition 24.296 (Circulation capture). *Circulation capture* is a process in which a position materially alters, intercepts, retains, conditions, redirects, or appropriates a value-bearing flow or its realization through control over a circulation path in a manner that changes the incidence or later generative availability of that value relative to a relevant alternative path or rule.

Capture can occur through pricing, fees, gatekeeping, proprietary standards, exclusive access, legal entitlement, administrative discretion, information asymmetry, platform rules, or control over recognition. It can also occur through path architecture: a position may not formally own the transmitted object yet can control the only feasible interface through which it becomes usable.

Definition 24.297 (Capture counterfactual). A *capture counterfactual* specifies the serious alternative routing, retention, realization, or governance condition against which a proposed circulation-capture claim is evaluated.

The counterfactual is necessary because some retention is constitutive of the service or institution. The relevant question is not whether an intermediary receives anything, but whether its control over the circulation architecture materially changes incidence, alternatives, or future generation in the manner claimed.

Proposition 24.298 (Capture non-equivalence principle). *Concentration, intermediary retention, unequal receipt, or unequal downstream benefit does not by itself establish circulation capture; the stronger attribution requires evidence of materially consequential control over routing, retention, terms, recognition, or realization relative to a defensible counterfactual.*

Capture can coexist with useful intermediation. A platform can reduce coordination costs while capturing data-based or financial value. A public institution can redistribute resources while acquiring administrative control. The analytical task is therefore mechanism-specific rather than binary.

24.12.8 Regeneration through Circulation

Regeneration is the positive-looking counterpart to dissipation, but it requires equally careful attribution. A system can circulate resources repeatedly while degrading the ecological, relational, institutional, or human capacities that make later circulation possible. Conversely, circulation can restore infrastructure, knowledge, trust, ecosystems, institutional capability, or other generative conditions. The open problem is to identify whether the circulation process actually contributes to restoring or expanding the conditions of future generation.

Definition 24.299 (Circulatory regeneration). *Circulatory regeneration* is a supported process through which one or more circulation paths restore, reproduce, repair, or expand a value-bearing condition or generative capacity that materially supports later activity within the specified system and horizon.

Regeneration can be direct, as when maintenance spending restores infrastructure, or indirect, as when circulating knowledge improves later organizational learning. It can also be cross-form: financial resources can support ecological restoration; community participation can produce institutional trust; public revenue can sustain education that later contributes to capability. Such cases may contain value conversion as well as circulation. The distinction should be preserved rather than folded into a generic claim of return.

Definition 24.300 (Regeneration dependence profile). A *regeneration dependence profile* records the circulation inputs, external supports, maintenance conditions, complementary relations, vulnerable interfaces, and affected positions on which an attributed regenerative process depends.

This profile prevents regeneration from being inferred solely from repeated continuation. A system can persist because external actors repeatedly absorb its costs. It can regenerate one capacity while depleting another. It can appear resilient only because environmental, care, or public infrastructures remain outside the accounting boundary.

Proposition 24.301 (Regeneration attribution condition). A *GRE claim of circulatory regeneration* should identify the condition being restored or expanded, the circulation path contributing to that change, the external and complementary supports required, and any materially significant depletion or burden displaced outside the focal path.

24.12.9 Non-Conservative Circulation Dynamics

Flow language easily invites a conservation metaphor. For some financial or material accounts, conservation-like identities can be justified within a specified boundary. GRE's broader value architecture cannot assume such a property. Knowledge can be copied without leaving the source. Trust can strengthen, weaken, or become differently distributed through repeated interaction. Rights can be extended to additional subjects without subtracting an identical quantity from previous holders. Ecological and material capacities can regenerate or degrade. Institutional recognition can create new opportunities while also excluding others. A circulation process can therefore replicate, amplify, dissipate, transform, or generate value-bearing conditions rather than merely reallocating a fixed stock.

Definition 24.302 (Non-conservative circulation). *Non-conservative circulation* is a circulation process in which the relevant value-bearing forms or generative conditions are not warranted to obey a fixed scalar conservation relation across the specified path and boundary because replication, generation, transformation, dissipation, capture, or regeneration materially changes the represented condition.

Non-conservation is not a claim that accounting identities are unimportant. It requires careful separation of the quantity being accounted for from the broader value claim. Money can be conserved within a closed accounting identity while capability, risk, control, trust, or ecological condition changes substantially. Likewise, a physical material balance can coexist with changing usability or relational significance.

Definition 24.303 (Conservation-claim warrant). A *conservation-claim warrant* states the exact quantity or relation claimed to be conserved, the analytical boundary, the measurement and composition rules, the processes treated as internal or external, and the empirical or institutional reason conservation is expected to hold within the stated scope.

Proposition 24.304 (No default conservation principle). *GRE should not infer conservation of heterogeneous value from the existence of a traceable circulation path; conservation may be imposed locally only for a specifically defined quantity and boundary for which the relevant warrant is independently established.*

This principle is essential for the later formalization subsection. A graph or flow diagram can depict transmission without committing the represented edge weights to a conserved quantity.

24.12.10 Formal Representations of Value Transmission

Formalization can clarify circulation when it preserves path, type, direction, timing, transformation, and incidence. It can also conceal the very distinctions the analysis needs if a generic weighted network is treated as self-explanatory. A transmission graph can show that two positions are connected while leaving unresolved what the edge means, what passes through it, whether the source retains the transmitted condition, whether the receiving position can use it, and whether intermediate transformation occurs.

Definition 24.305 (Typed transmission representation). *A typed transmission representation is a formal model in which the represented positions, relations, transmission events, value forms, temporal ordering, and transformation or composition rules are given explicit local semantics sufficient for the circulation claim the model is used to support.*

The formal object can be a directed graph, temporal network, higher-order relation, event sequence, multilayer representation, process model, or another structure. No one syntax is privileged. The choice should follow the empirical and conceptual structure of the circulation problem. A multilayer network can be useful when financial, epistemic, legal, and institutional paths interact while remaining differently typed. A temporal event model can be preferable when ordering and delay dominate. A higher-order representation can be necessary when a transmission requires a group configuration rather than pairwise edges.

Definition 24.306 (Composition burden). *The transmission-composition burden is the requirement to justify what it means to compose successive circulation segments when the transmitted forms, relations, scales, or domains differ, rather than assuming that path concatenation automatically preserves one homogeneous quantity or semantic type.*

Composition is particularly difficult under heterogeneous value. If knowledge becomes recognition and recognition later enables financial access, the path can be represented, but the two segments do not share one obvious scalar measure. A formal model can represent typed composition or a sequence of transformations without assigning a universal conversion coefficient.

Proposition 24.307 (Formal transmission restraint). *The inferential strength of a formal circulation model should not exceed the independently justified semantics of its positions, relations, transmission types, temporal structure, composition rules, and empirical mapping; formal path existence alone does not establish effective transmission, conservation, value equivalence, or causal sufficiency.*

Formal representations should also retain missing-path uncertainty. An observed network of transfers can omit informal exchange, care, unrecorded knowledge trans-

mission, externalized ecological effects, or hidden control relations. Section 24.5 therefore applies directly: missing relations can change circulation topology and attribution.

24.12.11 Heterogeneous-Form Transfer

Circulation often passes through several value forms. A public research grant becomes labor time, equipment access, knowledge, publications, training, organizational reputation, technical capability, policy influence, and perhaps later financial value. A household payment can become nutrition, time security, educational access, health capability, or debt reduction. The movement is real, yet it does not follow that one common value substance has been transferred through every stage.

Definition 24.308 (Heterogeneous-form circulation sequence). A *heterogeneous-form circulation sequence* is a circulation path containing two or more materially distinct value forms whose connection depends on one or more typed transfer, transmission, conversion, recognition, or generation mechanisms rather than on presumed identity of the forms.

The definition places the conversion discipline of Section 24.11 inside circulation analysis. Where the path changes value type, the conversion mechanism should be identified to the extent required by the claim. Where the same type is transferred, the transfer mechanism should be specified. Where a downstream form is newly generated rather than converted from the upstream form, the analysis should say so.

Definition 24.309 (Heterogeneous transmission ledger). A *heterogeneous transmission ledger* records, for each materially relevant path segment, the operative value form, transfer or transformation mechanism, affected positions, gain or loss attribution where supported, non-equivalence remainder, and evidential status of the linkage to the next segment.

The ledger is not an accounting device that forces commensuration. Its purpose is the opposite: to keep heterogeneous forms visible while preserving provenance. It can reveal where a circulation story contains an unsupported conversion, where the same output is counted twice, where a value form is lost from view after institutional reclassification, or where downstream generation has been mistakenly attributed to upstream transfer.

Proposition 24.310 (Heterogeneous-transfer non-identity principle). *Traceability across a heterogeneous circulation sequence establishes neither identity nor quantitative conservation of the value forms connected by that sequence; each materially relevant transition requires its own transfer, conversion, generation, or recognition warrant.*

24.12.12 Justice Conditions of Value Transmission

Circulation has normative consequences because path architecture distributes access, delay, burden, control, recognition, risk, and return. Yet the descriptive finding that one position contributes more, receives less, waits longer, or occupies a weaker path position does not settle a justice claim. Justice requires an independently specified normative framework and a defensible account of the positions and values that framework treats as relevant.

Definition 24.311 (Transmission-justice profile). A *transmission-justice profile* records the materially relevant contributors, recipients, intermediaries, affected non-recipients, path controllers, burdens, delays, risks, recognition, exit possibilities, returns, residual value, and future generative consequences that an independently specified normative analysis treats as relevant to evaluating a circulation process.

The profile can support several different normative questions. A distributive inquiry can ask who receives benefits and bears costs. A recognitional inquiry can ask whose contribution or value form is rendered legible. A participatory inquiry can ask who can alter the circulation rule. A relational inquiry can examine dependency, domination, reciprocity, or standing. An intergenerational inquiry can compare present extraction with later regenerative conditions. GRE can organize the relevant evidence, but the normative criterion should not be inferred from circulation efficiency or generativity alone.

Definition 24.312 (Transmission-rule contestability). *Transmission-rule contestability* is the practical capacity of materially affected positions to understand, question, challenge, negotiate, revise, or seek alternatives to the rules governing value transmission, routing, retention, recognition, and return within the relevant institutional setting.

Contestability is not a universal justice criterion, but its absence can be materially relevant when path control generates persistent dependence or forced commensuration. Similar caution applies to reciprocity. A circulation process can be just without symmetrical exchange, and symmetrical exchange can be unjust when the background positions are severely unequal. The evaluative task is therefore not to demand one circulation pattern but to expose the architecture through which normative claims can be argued and contested.

Proposition 24.313 (Transmission-justice non-derivation). *No finding about circulation efficiency, path centrality, value retention, recirculation, regeneration, or aggregate return is sufficient by itself to establish the justice of a transmission architecture; a justice conclusion requires an explicit normative warrant together with the incidence, control, recognition, participation, and temporal evidence material to that warrant.*

The open problems developed across this section can now be summarized by one broader discipline.

Proposition 24.314 (Value-circulation open-problem principle). *Value circulation should remain an open empirical and theoretical research object whenever the materially relevant path, domain or scale transitions, delays, re-entry structure, dissipation, capture, regeneration, transmission semantics, heterogeneous-form transitions, or justice-relevant incidence remain underdetermined; uncertainty in those dimensions should narrow the circulation claim rather than be absorbed into a generic metaphor of value flow.*

This principle preserves the usefulness of circulation while limiting its rhetorical expansion. A circulation account is strongest when it identifies how value-bearing conditions become consequential through time and relation without pretending that all movement is homogeneous, conserved, complete, or normatively desirable. The next section turns to power-theoretical limits. The value-path architecture developed here makes that transition direct: power can operate not only through possession or conversion, but through control over circulation routes, delay, recognition, retention, interruption, and the rules governing who can redirect or contest value transmission.

Table 24.13: Principal limits in GRE power analysis

Analytical object	Principal overreach risk	Required GRE discipline
Power as relation	Any consequential relation is re-described as power	Identify directional conditioning, affected possibilities, dependence, mechanism, and historical scope
Power as capacity	Mere possession or hypothetical ability is treated as operative power	Specify activation conditions, credibility, reach, alternatives, and the capacity–realization gap
Power as control	Formal authority or variable control is equated with power	Establish practical control over a consequential variable and its conversion into another position's constrained or redirected possibilities
Conversion power	Unequal conversion outcomes are attributed to an interface controller	Identify control over admission, rule, timing, recognition, alternatives, or revision and distinguish impersonal conversion conditions
Circulation power	Centrality, intermediation, or retention is treated as power automatically	Reconstruct routing, interruption, delay, retention, redirection, dependence, and feasible bypasses
Recognition power	Differential status or visibility is treated as sufficient for power	Show how recognition conditions access, standing, value realization, credibility, or later possibilities through an attributable mechanism
Persistent asymmetry	Durable inequality is treated as durable power	Reconstruct persistence of the conditioning mechanism, role continuity, counter-power, and alternative non-power explanations
Unified concept	Heterogeneous mechanisms are collapsed into one scalar or universal genealogy	Retain a minimal relational kernel with typed power profiles, partial comparability, and explicit non-equivalence remainders

24.13 Power-Theoretical Limits

Chapter 16 developed economic power as a relationally constituted, directionally organized, historically situated structure through which one position or organized configuration persistently and efficaciously conditions another economically relevant position's feasible action, access, capacities, relations, value processes, or future trajectories. Sections 24.11 and 24.12 have since made two especially important interfaces more explicit: power can operate through the conditions of value conversion and through control over circulation paths, retention, delay, recognition, and return. The role of the present section is to turn that expanded architecture back onto the concept of power itself. Its objective is not to replace the Chapter 16 account, but to identify the limits that arise when relational, modal, control-based, interface-based, and historical descriptions are treated as if they were interchangeable or scalar manifestations of one homogeneous substance. The method is reconstructive and type-preserving. Each power claim should state the affected relation, the conditioning capacity or mechanism, the practical alternatives, the relevant horizon, the historical supports, and the evidential basis for attributing the effect to a position or organized configuration.

The principal difficulty is conceptual overextension in two opposite directions. If power is defined so broadly that every relation, asymmetry, influence, constraint, central position, or consequential difference counts as power, the concept loses discrimination. If power is defined too narrowly as ownership, command, intentional coercion, or formal authority, GRE misses infrastructural, epistemic, symbolic, temporal, conversion, circulation, and distributed forms that materially condition feasible trajectories. The limitation problem is therefore one of preserving a sufficiently general power concept while retaining typed mechanisms and falsifiable attribution conditions.

Table 24.13 summarizes the principal limits developed below.

24.13.1 Power as Relation

GRE treats economic power as relationally constituted. This claim is analytically important because a resource stock, technical capability, legal office, reputation, database, infrastructure, or temporal advantage does not become power in isolation. It becomes power-relevant through a relation in which the position can condition another position's feasible action or future possibilities. Relational constitution, however, creates its own limit. If every economically consequential relation is called a power relation, the category ceases to distinguish cooperation, coordination, reciprocity, ecological dependence, technical constraint, ordinary specialization, and power.

Definition 24.315 (Power-relational attribution). A *power-relational attribution* is a claim that a specified relation or relational configuration carries economic power because it supplies an identifiable directional mechanism through which one position or organized configuration materially conditions another position's feasible action, access, capacities, relations, value processes, or future trajectories over a stated historical scope.

The definition preserves the stronger Chapter 16 criterion. Relationality supplies the architecture within which power can exist; it is not itself sufficient evidence of power. A mutually beneficial specialization relation can generate reciprocal dependence without either side possessing stable conditioning capacity over the other. A person can depend on an ecosystem without the ecosystem becoming an economic power-holder in the sense used here. A firm can face a technical constraint that no identifiable actor or organized configuration can selectively alter. These cases remain relationally structured while failing the attribution burden for economic power.

The same caution applies to directional effect. A relation can affect another position without supplying power to the source position. One household's purchase can alter a seller's revenue; one firm's innovation can change competitive conditions; one migration decision can affect a local labor market. The stronger power interpretation requires a practically consequential capacity or organized mechanism that can condition possibilities in a manner not exhausted by ordinary causal participation in a connected economy.

Definition 24.316 (Relational-power specificity burden). The *relational-power specificity burden* is the requirement that a GRE power claim identify the relation, direction of conditioning, affected possibility or capacity, relevant dependence, operative mechanism, practical alternatives, and historical horizon that distinguish the proposed power relation from ordinary relational causation or interdependence.

A relation can also contain reciprocal power. Position *A* can condition *B* through access to finance while *B* conditions *A* through scarce technical expertise. The existence of both directions does not cancel power, nor does it imply a single net rank. The relations can differ in object, horizon, intensity, reversibility, and substitutability. A relational analysis therefore supports typed directional claims more readily than an aggregate statement that one party is simply "more powerful."

Proposition 24.317 (Relational non-totalization of power). *Evidence that one position carries a power relation toward another in a specified domain does not establish a general ranking of the positions across other relations, mechanisms, horizons, or affected possibilities; reciprocal, orthogonal, or incomparable power components can coexist within the same coupled configuration.*

The relational conception of power is therefore strongest when it narrows rather than universalizes the claim. It asks *who or what conditions whom, through which relation, with respect to which possibilities, under which alternatives and horizon*. The answer can be distributed across several actors, institutions, infrastructures, and procedures. Distributed attribution does not weaken the relation account, but it does require the analyst to avoid assigning to one visible actor a capacity carried by a larger configuration.

24.13.2 Power as Capacity

Power is often described modally: a position can withhold a resource, alter a rule, deny access, impose delay, redirect a path, classify a claim, or exit a relation even when the capacity is not currently exercised. Chapter 16 already distinguished power capacity from overt exercise because credible capacities can condition behavior before intervention occurs. The open limit concerns how far this modal reasoning can extend before power becomes indistinguishable from merely conceivable ability.

Definition 24.318 (Power-capacity attribution). A *power-capacity attribution* is a claim that a position or organized configuration possesses a practically credible ability to activate, maintain, withhold, modify, or redirect a mechanism that would materially condition another position's feasible action or future trajectory under specified activation conditions and within a stated horizon.

Credibility matters. A contractual right that cannot be enforced, a veto that cannot be used without destroying the holder's own essential capacity, a technical permission unavailable in practice, or a nominal exit option whose exercise is prohibitively costly may supply weak evidence of operative power. Conversely, a capacity need not be exercised repeatedly when the affected position reasonably anticipates that it can be exercised and organizes behavior around that expectation.

Definition 24.319 (Capacity-realization gap). The *capacity-realization gap* is the analytically material difference between a represented power capacity and the historically operative conditioning relation produced when activation conditions, credibility, complementarity, institutional uptake, resistance, and practical alternatives are taken into account.

The gap can run in both directions. Formal capacity can overstate practical power when implementation is weak, countervailing institutions are strong, or substitutes are abundant. Observable exercise can also understate capacity when compliance occurs in anticipation of intervention and the holder rarely needs to act overtly. Empirical analysis should therefore combine evidence about rights, resources, technical ability, organizational routines, prior use, credible threats, expectations, dependence, and actual alternatives rather than infer power from any single indicator.

Capacity claims are also horizon-dependent. A dominant supplier can possess substantial short-run power while substitution becomes feasible over several years. A regulator can have immediate authority but limited capacity to sustain enforcement. A worker with scarce expertise can possess bargaining capacity during a project deadline but not after organizational learning diffuses the knowledge. The capacity should therefore be indexed to the period during which the proposed intervention remains practically consequential.

Proposition 24.320 (Modal restraint in power attribution). A *hypothetical ability supports a strong GRE power claim only to the extent that the inquiry can justify its prac-*

tical credibility, activation conditions, consequential reach, temporal horizon, and relation to the affected position's effective alternatives; remote or institutionally unrealizable possibilities should not be treated as equivalent to operative conditioning capacity.

Power as capacity is thus neither purely dispositional nor reducible to observed exercise. The limitation discipline is to keep the modal component empirically and historically tethered. This also protects the later analysis of persistent power: a structure can remain powerful through credible capacity even during periods of quiescence, but the inference cannot survive indefinitely without evidence that the relevant activation architecture remains operative.

24.13.3 Power as Control

Control is one important mechanism through which capacity becomes power. Chapter 16 defined control capacity as the practically effective ability to set, maintain, alter, withhold, authorize, sequence, or condition a variable that contributes materially to another position's feasible action or future trajectories. The limitation is that control and power are not equivalent concepts. A position can control a variable that is economically irrelevant to others, while a position can possess power through dependence, exit, symbolic authority, or infrastructural position without directly controlling another actor's behavior.

Definition 24.321 (Control–power conversion burden). The *control–power conversion burden* is the requirement that a GRE analysis show how practical control over a specified variable is converted into material conditioning of another position's feasible action, access, capacities, relations, value processes, or future trajectories rather than inferring power from control status alone.

Formal authority is a common source of over-attribution. Ownership, office, administrative jurisdiction, voting rights, technical permissions, or contractual clauses can identify a potential control channel. They do not settle whether the holder can use the channel effectively. Implementation capacity, legal review, countervailing authority, technical interdependence, organizational resistance, public accountability, and practical alternatives can all narrow the effect. The inverse error also occurs when informal or distributed actors exercise substantial practical control without holding the formal entitlement most visible in the record.

Control can be partial and distributed. A payment architecture can divide rule-setting, verification, liquidity provision, routing, settlement, dispute resolution, and technical maintenance across different organizations. A platform can control ranking while sellers control inventory and users control participation. A public agency can set eligibility while courts constrain interpretation and local organizations mediate access. The power analysis should therefore identify which consequential variable each position can condition rather than attributing sovereignty to the system's most visible node.

Definition 24.322 (Distributed control profile). A *distributed control profile* records the consequential variables in a power-relevant process, the positions able to condition each variable, the conditions and limits of that control, the dependencies linking the positions, and the review, veto, substitution, or counter-power mechanisms capable of modifying the resulting effect.

Control also differs from influence. Influence can alter expectations, salience, preference, interpretation, or coordination without providing a reliable capacity to set

a consequential variable. Influence can still become power when it enters a reproducible mechanism that materially conditions another position's possibilities. The evidential burden should then concern the mechanism and its consequences, not the analyst's intuition that persuasion or prestige "feels powerful."

Proposition 24.323 (Control non-equivalence principle). *Neither formal control nor practical influence is sufficient by itself to establish economic power; the stronger claim requires an identifiable mechanism connecting a practically effective control or influence capacity to material conditioning of another economically relevant position under the stated alternatives and historical scope.*

The distinction matters because a control-centered theory can become too narrow, while an influence-centered theory can become too broad. GRE can retain both by treating control as one typed mechanism within a larger relational account of power rather than as the essence of power itself.

24.13.4 Power over Conversion

Section 24.11 showed that value conversion depends on conditions and interfaces rather than on the source value form alone. Power becomes relevant when some positions can materially shape those conversion conditions. Admission rules, eligibility categories, recognition standards, timing, pricing, documentation, interface design, appeals, complementary resources, and revision procedures can each determine whether a nominal resource or value-bearing condition becomes effective capacity or later value.

Definition 24.324 (Conversion power). *Conversion power* is economic power whose principal conditioning mechanism arises from a position's practically consequential capacity to shape the conditions, rules, interfaces, timing, recognition, alternatives, or revision procedures through which another position attempts to convert a specified source value form into a target value form or capability.

This definition is narrower than the existence of unequal conversion rates. Two people can convert the same nominal resource differently because of health, geography, technology, ecological conditions, prior learning, stochastic events, or complementary resources that no relevant actor controls. A power claim requires an attributable relational mechanism. The analyst should therefore separate an adverse conversion environment from a conversion architecture that another position or organized configuration can materially shape.

Definition 24.325 (Conversion-power attribution profile). A *conversion-power attribution profile* records the source and target forms, the conversion interface, the consequential rule or condition under control, the controlling position or configuration, the affected position's dependence and alternatives, the available review or bypass mechanisms, and the evidence linking control of the interface to the observed conversion possibility or failure.

Conversion power can operate without directly denying conversion. A gatekeeper can impose delay, increase documentary burden, reduce target recognition, narrow the set of acceptable source forms, or control which alternatives are visible. The effect can therefore concern probability, cost, timing, durability, or recognized status rather than a binary permission. Power can also operate through the ability to revise the conversion rule, which is a stronger historical position than merely administering a fixed procedure.

Definition 24.326 (Conversion-rule power). *Conversion-rule power* is conversion power exercised through material influence over the creation, interpretation, modification, exception structure, or revision of the rules that determine which source conditions are admissible and how they can become target value or capability.

A position that controls current conversion outcomes but cannot alter the governing rule differs from a position able to redesign the conversion architecture. The latter can reshape future asymmetries and generate path dependence. Yet rule influence still requires evidence of consequential uptake. A proposed rule that is ignored or routinely circumvented can supply much less power than its formal status suggests.

Proposition 24.327 (Conversion-outcome non-attribution). *Persistent inequality in conversion outcomes does not by itself establish conversion power; GRE should attribute conversion power only where an identifiable position or organized configuration can materially condition the conversion architecture or its effective alternatives and where that conditioning contributes to the differential conversion possibilities under examination.*

This limitation is important for justice analysis. Unequal conversion can be unjust even when no single power-holder caused it, and conversion power can exist even where outcomes happen to be equal in one observed episode. Description of power and normative evaluation should therefore remain distinct.

24.13.5 Power over Circulation

Section 24.12 reconstructed circulation as a path architecture containing routing, mediation, delay, transformation, retention, re-entry, dissipation, and return. Power can enter at any of these points. A position can control entry to a route, select among paths, delay transmission, retain an intermediate value-bearing condition, redirect flows, interrupt transmission, determine return terms, or prevent affected positions from using alternative routes. This is analytically distinct from simply occupying a central network position.

Definition 24.328 (Circulation power). *Circulation power* is economic power whose principal conditioning mechanism arises from a position's practically consequential capacity to route, delay, retain, interrupt, redirect, transform, prioritize, or condition access to a value-circulation path on which other positions materially depend within the stated domain and horizon.

Centrality can correlate with such power without establishing it. A highly connected node can be easily bypassed, governed by strict nondiscretionary rules, technically interchangeable, or unable to retain what passes through it. A less central node can possess substantial power if it controls a unique bottleneck or a legally indispensable validation step. The relevant object is therefore not structural centrality by itself but the conversion of position into consequential path control.

Definition 24.329 (Circulation-power profile). *A circulation-power profile* records the relevant path segment, the position's routing or interruption capacities, the value-bearing forms affected, the degree of path dependence, available bypasses, temporal exposure, retention or redirection possibilities, downstream incidence, and the institutional or technical constraints on exercising the capacity.

Circulation power can be distributed. One intermediary can control authentication, another settlement, another routing, another recognition, and another appeals.

The combined architecture may condition participants more strongly than any single actor can. Attribution should then remain configurational rather than assigning the complete power relation to whichever intermediary is most visible.

Capture and circulation power also need separation. Section 24.12 defined circulation capture by control over routing, retention, recognition, terms, or realization relative to a defensible counterfactual. Circulation power can exist without capture when a position can redirect or interrupt value but does not appropriate the relevant value. Capture can also depend on several forms of power together, including institutional, infrastructural, epistemic, or symbolic power.

Proposition 24.330 (Path-position non-equivalence). *A position's location, centrality, or intermediation within a circulation path does not establish circulation power unless that position possesses a practically consequential and sufficiently attributable capacity to condition routing, timing, retention, transformation, interruption, recognition, or feasible bypasses for other materially dependent positions.*

The same discipline applies to apparently decentralized architectures. Technical distribution can reduce some forms of unilateral control while leaving governance, standards, identity, liquidity, infrastructure, or recognized interfaces concentrated elsewhere. The power analysis should follow the effective control architecture rather than infer decentralization or centralization from one layer alone.

24.13.6 Power over Recognition

Recognition is economically consequential when classifications, credentials, reputations, identities, statuses, legal categories, expert judgments, rankings, or institutional acknowledgments condition access, standing, credibility, participation, or value realization. Chapter 16 treated symbolic and epistemic power as distinct but interacting forms. The present subsection isolates a recurring limit: recognition differences are often visible, yet the mechanism through which recognition becomes power can remain under-specified.

Definition 24.331 (Recognition power). *Recognition power* is economic power whose principal conditioning mechanism arises from a position's practically consequential capacity to confer, withhold, classify, validate, rank, render visible, or institutionally stabilize a recognized status that materially alters another position's access, standing, credibility, value realization, participation, or future possibilities.

Recognition power is not identical to social esteem. A person can be admired without controlling another's possibilities. A credentialing body can possess recognition power because its classification changes eligibility or standing even when its members do not personally esteem the applicant. A platform ranking can acquire recognition power when visibility materially conditions demand. A public authority can confer legally consequential status, while a professional community can stabilize an epistemic category that shapes later institutional treatment.

Definition 24.332 (Recognition-consequence bridge). *A recognition-consequence bridge* is the evidenced mechanism through which a recognized classification, status, credential, rank, visibility state, or validation decision changes materially relevant access, standing, participation, value realization, or future possibilities for the affected position.

Without such a bridge, recognition analysis can slide from descriptive difference

into power attribution too quickly. The same status can matter greatly in one institutional environment and little in another. Recognition can also be plural: one institution may reject a credential while another accepts it; a community can recognize a contribution that a market ignores; legal recognition can coexist with weak practical uptake. The power claim should therefore specify which recognition order is consequential and why.

Recognition power can also become reflexive. A classification changes access; changed access produces new records; those records reinforce the classification; later institutions treat the accumulated record as independent evidence. Chapter 24's earlier analysis of performative representation is directly relevant. The recursive effect can strengthen power while simultaneously making its origin harder to reconstruct.

Proposition 24.333 (Recognition–legitimacy separation). *The practical efficacy of a recognized status does not establish the epistemic validity, legal correctness, social desirability, or normative legitimacy of the recognition rule that produced it; recognition power and the justification of recognition remain distinct analytical questions.*

This separation is especially important where rankings, credentials, eligibility categories, and automated classifications become highly consequential. GRE can analyze how recognition conditions economic possibilities while deferring the substantive validity of the underlying category to the relevant epistemic, legal, political, educational, or normative domain.

24.13.7 Power under Persistent Asymmetry

Persistent asymmetry is one of the strongest empirical signals that power may be reproduced, but it remains an insufficient criterion. Durable differences in wealth, capability, geography, organizational role, technical specialization, legal status, ecological exposure, or network position can persist for reasons that do not satisfy the GRE definition of power. Conversely, a power structure can persist while the visible asymmetry, institutional carrier, or local mechanism changes.

Definition 24.334 (Persistent-asymmetry audit). *A persistent-asymmetry audit is a historical reconstruction that tests whether a durable directional difference is sustained through an identifiable power mechanism, through non-power structural conditions, through several interacting mechanisms, or through changing role-equivalent arrangements whose continuity must be independently justified.*

The audit should distinguish persistence of the difference from persistence of the power relation. An inherited resource disparity can remain large while the former gatekeeping mechanism dissolves. A formal hierarchy can remain stable while practical control shifts elsewhere. A platform's market share can fall while infrastructural or data dependence preserves another form of conditioning capacity. The historical continuity claim should identify what remains invariant enough to support talk of persisting power.

Chapter 16 introduced adaptive persistence to capture cases in which manifestations, mediators, institutional carriers, or supporting mechanisms change while a directional dynamical role remains historically connected. This concept is useful, but it carries a retrospective danger. If the role-equivalence criterion is defined after observing every successor arrangement, almost any later asymmetry can be narrated as continuation of the earlier power structure.

Definition 24.335 (Power-continuity warrant). A *power-continuity warrant* is the explicit criterion and evidence supporting the claim that historically successive power configurations preserve a materially relevant directional conditioning role despite changes in carrier, manifestation, institutional form, or local mechanism.

The warrant should state both preservation and discontinuity. It should identify which affected positions, possibilities, access relations, interfaces, or dependence structures remain sufficiently connected, and which dimensions changed enough to limit the continuity claim. Power history becomes more credible when it permits genuine dissolution and reformation rather than presuming that power merely changes costume.

Persistent asymmetry can also be maintained by feedback between power and the conditions supporting power. Conversion power can shape capabilities that later reinforce interface control; circulation power can concentrate resources used to govern the circulation architecture; recognition power can create records that stabilize future recognition. Yet feedback should be reconstructed rather than inferred from persistence alone.

Proposition 24.336 (Persistent-asymmetry non-equivalence). *The durability of an asymmetry does not by itself establish persistence, reproduction, or identity of a power relation; those stronger claims require evidence that an identifiable conditioning mechanism or warranted role-equivalent successor continues to shape the affected positions' possibilities across the declared historical scope.*

This discipline also creates room for counter-power. Persistent asymmetry can co-exist with institutions, collective organization, legal protections, public alternatives, technical substitution, or reciprocal dependence that materially limit its conversion into power. GRE should therefore reconstruct the realized power architecture rather than infer it directly from the magnitude or duration of inequality.

24.13.8 Limits of a Unified Power Concept

GRE requires a concept of power general enough to connect resource, capability, epistemic, relational, institutional, infrastructural, symbolic, temporal, exit, conversion, circulation, and recognition mechanisms. At the same time, the book has repeatedly rejected the idea that these forms are scalar manifestations of one measurable substance. The final limitation is therefore architectural: how much conceptual unity can GRE preserve without erasing the mechanisms that make different power relations intelligible?

Definition 24.337 (Minimal GRE power kernel). The *minimal GRE power kernel* is the family resemblance retained across GRE power claims: a historically situated and relationally organized capacity or structure must, through an identifiable directional mechanism, materially condition another economically relevant position's feasible action, access, capacities, relations, value processes, or future possibilities within a declared scope.

The kernel is deliberately weaker than a universal metaphysics of power. It does not require every power relation to originate in the same antecedent asymmetry, operate through direct control, involve conscious intention, produce injustice, reproduce itself, or admit a common metric. It instead specifies the minimum structure that makes the term useful within GRE's economic domain.

Definition 24.338 (Typed power profile). A *typed power profile* records, for each power claim, the principal carrier, conditioning mechanism, affected position, affected possibility or value process, dependence relation, alternatives, historical horizon, persistence, causal or generative efficacy, manifestation, counter-power, and uncertainty relevant to that claim.

Typed profiles permit comparison without presuming equivalence. Two power relations can be comparable with respect to one feature, such as reversibility or control over exit, while remaining incomparable with respect to another. A regulator's legal authority, a platform's infrastructural gatekeeping, and a creditor's liquidity control can all condition feasible action while doing so through different institutions, evidence, time horizons, and modes of contestability.

Definition 24.339 (Power incomparability remainder). A *power incomparability remainder* is the set of materially relevant dimensions of two or more power profiles that are not preserved by a proposed common comparison or scalarization and whose omission could alter the interpretation of dependence, reach, reversibility, contestability, historical persistence, or downstream consequence.

This remainder does not prohibit aggregation for a bounded purpose. A governance study can construct an index of selected decision rights, a network analysis can compare brokerage, and an empirical study can estimate effects of particular institutional powers. The limitation arises when the local index is interpreted as total power or transferred across heterogeneous mechanisms without preserving the omitted dimensions.

Proposition 24.340 (Power-composition without scalarization). *Multiple forms of economic power can jointly support, counteract, convert into, or condition one another without being reducible to a single additive power quantity; GRE should preserve the typed mechanisms and their interaction unless a specific scalar representation has an independently justified domain, semantics, and aggregation rule.*

The unified concept also remains genealogy-limited. Chapter 16 explicitly developed an asymmetry-derived construction of economic power and left other genealogies open. The present section does not close that opening. Future research may identify power relations better reconstructed through constitutive authority, subject formation, institutional emergence, collective coordination, or other mechanisms not captured adequately by the current sequence from asymmetry through power relevance to relational realization.

Definition 24.341 (Power-theory revision trigger). A *power-theory revision trigger* is recurrent evidence that economically consequential conditioning cannot be adequately represented by the current GRE power kernel or its typed mechanisms without semantic expansion, ad hoc exceptions, persistent misclassification, or loss of distinctions material to explanation, comparison, or intervention.

Revision can take several forms. GRE can add a new typed mechanism, narrow an existing form, split one category, merge categories shown to be redundant, revise the minimal kernel, or concede that a phenomenon belongs principally to another domain's power theory. The aim is not conceptual stability at any cost, but disciplined continuity under correction.

Proposition 24.342 (Power-theoretical limitation principle). *GRE should treat power as a typed and historically revisable relational architecture rather than as a universal scalar substance: relation, capacity, control, conversion, circulation, recognition, and*

persistent asymmetry can each contribute to power analysis, but none is individually sufficient or universally necessary, and claims of unity should preserve the mechanisms, non-equivalences, and revision conditions material to the inquiry.

This limitation principle preserves the explanatory reach of GRE's power framework while making its boundaries visible. Power remains central because it can shape conversion, circulation, recognition, institutional rules, and future generative conditions. The concept remains scientifically useful only if those pathways can be reconstructed and, where evidence fails, withheld or revised. The next section applies the same discipline to justice. Power analysis can organize evidence about dependence, control, recognition, circulation, vulnerability, and future possibility, but no description of power by itself settles how the resulting relations ought to be evaluated.

24.14 Justice-Theoretical Limits

Chapter 16 developed distributional, relational, generative, relation-variation, and historical dimensions of justice, while Chapter 22 converted those dimensions into a research programme that separates descriptive reconstruction from normative premises. Sections 24.9–24.13 have since sharpened several objects on which justice analysis depends: heterogeneous value, partial and forced commensuration, value conversion, value circulation, and typed economic power. The role of the present section is to turn those refinements back onto justice theory itself. Its objective is to identify where a GRE justice claim becomes underdetermined, overextended, or falsely unified when distribution, recognition, participation, relation quality, generativity, conversion, temporal inheritance, heterogeneous value, or transfer is treated as a sufficient indicator of justice. The method is normatively explicit and type-preserving. Descriptive incidence, causal or generative mechanism, power relation, feasible alternative, affected position, temporal horizon, and evaluative premise should be distinguished even when they interact within one judgment.

The governing limitation is that GRE can reconstruct justice-relevant economic structure more richly than it can determine a uniquely correct normative ordering from that structure alone. This is not a defect specific to GRE. It is a reason to preserve the distinction between identifying what happened, who was affected, through which mechanisms, with which alternatives, and evaluating what ought to have happened or which claims should receive priority. A distribution can be equal and still procedurally or relationally objectionable. A relation can be participatory while reproducing severe material burdens. An arrangement can generate substantial future capability while violating rights or imposing ecological costs. A transfer can improve one recipient's resources while worsening dependence or leaving historical harm unaddressed. A justice framework that treats one of these dimensions as self-interpreting risks turning an analytically useful lens into a master criterion.

Definition 24.343 (Justice-theoretical limitation profile). *A justice-theoretical limitation profile* records the justice-relevant economic objects, affected positions, descriptive and causal claims, power relations, feasible alternatives, temporal scope, normative premises, comparison rules, unresolved value conflicts, representational limits, uncertainty, and revision conditions that bound a GRE justice judgment.

The profile extends the justice-research and normative-premise disciplines of Chap-

Table 24.14: Principal limits in GRE justice analysis

Justice object	Characteristic overreach	Required GRE discipline
Distribution	A measured distribution is treated as normatively self-interpreting	State object, unit, baseline, horizon, conversion conditions, affected positions, and evaluative rule
Recognition	Institutional recognition or visibility is equated with just recognition	Separate recognition incidence, standing, authority, accuracy, burden, and normative warrant
Participation	Inclusion is treated as sufficient for justice	Examine influence, information, burden, accessibility, representation, contestability, and consequences
Relational justice	Several relational dimensions are collapsed into one relation-quality score	Preserve recognition, reciprocity, dependence, domination, continuity, consent, voice, and exit as partially independent
Generative justice	More generation or more options are treated as better or more just	Identify what is generated, for whom, at whose cost, with which foreclosures, and under which normative premise
Conversion justice	Unequal conversion outcomes are treated as evidence of injustice by themselves	Reconstruct interface terms, power, loss, alternatives, voluntariness, residual value, and evaluative standard
Intergenerational justice	Present actors claim determinate knowledge of future interests	Preserve uncertainty, representation limits, transmission mechanisms, reversibility, and future revision capacity
Incommensurable values	Absence of one metric is treated as impossibility of judgment, or one procedure is treated as neutral	Use bounded comparison, thresholds, rights, deliberation, or explicit priority rules while recording residual disagreement
Normative underdetermination	Rich description is presented as yielding one uniquely correct normative conclusion	Record serious competing principles, their implications, and the premises on which conclusions diverge
Transfer justice	Nominal transfer is treated as equivalent to just incidence or complete repair	Trace formal, economic, relational, generative, historical, and third-party incidence together with conditions and alternatives

ter 22. It is especially useful in Chapter 24 because it records not only what supports a justice claim but also what the claim does not establish. A study can strongly identify unequal conversion conditions while remaining normatively open between equality, priority, sufficiency, rights, reciprocity, or another principle. Another study can share the same normative principle while remaining empirically uncertain about who actually bears the burden. Locating the limitation prevents these disagreements from being collapsed into one undifferentiated dispute about “justice.”

Table 24.14 summarizes the principal limits developed below.

24.14.1 Distribution

Chapter 16 showed that distribution in GRE can concern resources, capabilities, usable access, relational opportunities, participation, burdens, and future possibilities rather than one scalar stock. This multidimensionality improves descriptive analysis but also enlarges the normative burden. A finding that one distribution is more equal, more concentrated, or more dispersed than another does not establish whether the pattern is just because justice depends on what is distributed, among which positions, relative to which baseline and horizon, under which conversion conditions, and according to which evaluative principle.

Definition 24.344 (Distributional-justice bridge). A *distributional-justice bridge* is the explicit normative and empirical linkage connecting a reconstructed distribution to a justice judgment by specifying the distributed object, comparison unit, affected positions, relevant baseline, temporal horizon, conversion conditions, feasible alternatives, and evaluative principle under which the pattern is judged.

The bridge is necessary because the same numerical distribution can carry different normative meanings under different institutions. Equal cash transfers can pro-

duce highly unequal effective capabilities where accessibility costs, care burdens, legal status, geography, infrastructure, or conversion interfaces differ. Unequal transfers can sometimes reduce a pre-existing capability disadvantage. Equal shares can be objectionable when prior extraction, need, responsibility, contribution, historical harm, or rights are normatively relevant. Conversely, invoking contextual difference can also become an excuse for entrenched inequality unless the proposed differentiation is independently justified.

Distributional analysis is therefore vulnerable to at least three compression errors. The first compresses heterogeneous objects into one metric. The second compresses persons or positions into equivalent conversion units. The third compresses temporal incidence into a present snapshot. GRE's multidimensional architecture helps reveal these errors, but it cannot decide by description alone which dimension should receive normative priority.

Proposition 24.345 (Distributional pattern non-sufficiency). *No observed degree of equality, inequality, concentration, dispersion, sufficiency, or aggregate improvement is by itself sufficient to establish the justice of an economic arrangement without an explicit account of the relevant object, affected positions, conversion conditions, baseline, alternatives, and normative principle.*

The proposition does not weaken distributive evidence. It states the level at which the evidence is probative. A distributional pattern can establish who receives what and how that pattern changes. A conversion analysis can establish why nominally similar holdings produce different effective capabilities. A power analysis can identify who controls the rules of access. Justice enters when those findings are evaluated through principles whose authority is not supplied by the descriptive pattern alone.

24.14.2 Recognition

Recognition entered the earlier justice architecture as a relation of standing, visibility, acknowledgment, and institutional treatment. Section 24.13 also showed that recognition can become a power mechanism when classifications, credentials, rankings, statuses, or validation decisions materially condition access and future possibilities. These findings create a justice-theoretical limit because recognition has both descriptive and normative meanings. A person can be recognized administratively without being recognized justly; a category can increase visibility while imposing stigma or surveillance; refusal to recognize a harmful or fraudulent claim can sometimes be warranted.

Definition 24.346 (Recognition-justice profile). *A recognition-justice profile records the recognized position or claim, recognizing authority, recognition rule, practical consequences, evidential or institutional basis, burdens created by classification, opportunities for correction or contestation, excluded or residual identities, and the normative premise used to judge the recognition relation.*

Recognition justice therefore cannot be reduced to maximizing recognition. Institutional recognition can enable access to rights, resources, credibility, participation, or remedies. It can also stabilize categories that misdescribe subjects, force heterogeneous positions into administratively convenient identities, or make populations more governable without increasing their practical agency. The relevant question is not only whether recognition occurred but what kind of standing the recognition created, which authority produced it, how revisable it is, and how its consequences are

distributed.

The inverse case also matters. Non-recognition can be unjust when it erases contributions, harms, identities, claims, or affected positions. Yet non-recognition can also reflect uncertainty, jurisdictional limits, or refusal to validate an unsupported assertion. GRE therefore requires a bridge between recognition incidence and normative evaluation rather than assuming that visibility and justice move monotonically together.

Proposition 24.347 (Recognition-incidence non-equivalence). *The presence, absence, intensity, or institutional durability of recognition does not by itself establish recognition justice; a justice claim additionally requires evaluation of standing, authority, representation, consequences, burdens, contestability, and the substantive warrant for the recognition rule.*

This limitation is important in AI-mediated and data-intensive institutions, where recognition is increasingly produced through scoring, classification, ranking, and machine-mediated validation. GRE can analyze the economic consequences of these recognition systems. Whether their categories are epistemically valid, legally authorized, politically legitimate, or morally just can require warrants from neighboring domains and explicit normative premises.

24.14.3 Participation

Participation is central to both relational and generative justice because economic subjects can be affected by rules, infrastructures, allocations, and generative processes in which they have unequal opportunity to speak, contest, revise, or contribute. Participation is nevertheless vulnerable to a procedural overreach: the existence of a participatory procedure can be treated as sufficient evidence that the resulting arrangement is just.

Definition 24.348 (Participation-justice profile). *A participation-justice profile records eligibility, accessibility, information, timing, effective influence, representation, participation burden, power asymmetry, agenda control, contestability, exit, feedback, decision consequences, and the normative significance assigned to participation in the inquiry.*

The distinction between access and influence is especially important. A consultation can be formally open while agenda setting, technical language, timing, documentation requirements, or institutional hierarchy sharply constrain which contributions alter the decision. Conversely, a procedure can legitimately assign differentiated authority when expertise, fiduciary responsibility, legal competence, or delegated roles are relevant. Justice does not therefore require that every participant exercise identical influence over every question.

Participation also has costs. Time, emotional labor, translation, travel, disclosure, caregiving, technical preparation, and repeated consultation can impose substantial burdens on the very positions whose inclusion is sought. Participation can become compulsory proof of deservingness or a substitute for institutional responsibility. A justice analysis should therefore ask not only whether voice exists, but whether participation is usable, consequential, proportionate, supported, and non-exploitative.

Proposition 24.349 (Participation non-sufficiency). *Meaningful participation can strengthen the justice of an economic process, but participation alone does not estab-*

lish the justice of the resulting distribution, relation, rule, or outcome where material burden, domination, exclusion, rights, historical claims, or substantive value conflicts remain unresolved.

The proposition preserves participation as a constitutive or instrumental value where the applied theory warrants it while rejecting a procedural shortcut. A highly participatory institution can still produce severe injustice. A constrained procedure can sometimes be justified under emergency, expertise, or rights-protecting conditions, though such constraints themselves require justification and review.

24.14.4 Relational Justice

Chapter 16 defined economic relational justice through recognition, participation, reciprocity, non-domination, continuity, exit, and the terms of value transmission. Its strength is that it makes visible injustices that a distributional snapshot can miss. Its limit is that these relational dimensions do not automatically align. A relation can be reciprocal yet dominating, continuous yet exclusionary, participatory yet materially exploitative, protective yet paternalistic, or unequal yet normatively justified by care, responsibility, expertise, or temporary role differentiation.

Definition 24.350 (Relational-justice decomposition). *A relational-justice decomposition is a typed assessment of the distinct justice-relevant properties of an economic relation, including recognition, participation, reciprocity, dependence, domination, authority, consent, continuity, voice, exit, burden, vulnerability, and revision, without presuming that these properties admit one complete scalar ordering.*

The decomposition prevents the phrase “just relation” from concealing internal conflict. For example, continuity can protect trust, care, employment security, or long-term investment, but continuity can also entrench dependence. Exit can protect against domination, but a policy that maximizes exit can weaken commitments necessary for care, public provision, or collective projects. Reciprocity can support mutual standing while being inappropriate as the sole standard for children, persons with unequal capacities, future persons, or relations organized around care and need.

Relational justice therefore needs a conflict discipline rather than a universal relational score. The applied normative framework must state which properties receive priority and why. GRE contributes by reconstructing the relation and the mechanisms through which its terms become consequential; it does not acquire authority to rank all relational goods merely because they are represented within one framework.

Definition 24.351 (Relational-justice conflict). *A relational-justice conflict occurs when improving one justice-relevant property of a relation materially worsens another property that remains normatively relevant under the applied framework, so that no purely descriptive relation-quality improvement determines the preferred resolution.*

Proposition 24.352 (Relational pluralism constraint). *A GRE relational-justice claim should not infer overall justice from improvement in one relational dimension when other independently relevant dimensions deteriorate materially; the conflict should remain explicit unless an applied normative principle justifies the priority or tradeoff.*

This constraint also limits the reach of power analysis. Domination and dependence are important justice objects, but the presence of power does not prove injustice and the absence of identifiable power does not prove justice. Rights violations, ne-

glect, structural exclusion, or severe deprivation can remain unjust without a strong dyadic power attribution. Justice therefore requires a wider normative architecture than power theory alone.

24.14.5 Generative Justice

Generative justice evaluates how economic arrangements shape capacities, opportunities, option spaces, participation in generation, protection against generative foreclosure, and later possibility. The concept is distinctive to GRE's substantive architecture, but it carries a recurrent danger: generativity can be mistaken for an intrinsic master value. Section 24.9 already established that generative value requires a separate evaluative warrant. The same discipline applies more strongly to justice.

Definition 24.353 (Generative-justice bridge). A *generative-justice bridge* connects a reconstructed change in capacities, opportunities, option spaces, relations, or future possibilities to a justice judgment by specifying affected positions, what is generated or foreclosed, temporal horizon, distribution, burdens, power relations, reversibility, competing values, and the normative principle under which the generative effect is evaluated.

Option expansion provides a clear example. An arrangement can increase the number of technically available actions while increasing surveillance, instability, ecological burden, or dependence. Some options are harmful or trivial; some valuable activities require commitment that deliberately narrows later flexibility. A justice theory cannot therefore maximize option cardinality without specifying option quality, accessibility, distribution, and the values that make particular possibilities worth protecting.

Generative capacity is similarly ambiguous. An institution can become highly capable of producing innovation while concentrating ownership, externalizing ecological cost, or narrowing public control. A society can preserve future productive capacity by imposing present burdens that fall disproportionately on vulnerable positions. A policy can protect one generation's ability to revise institutions while reducing certainty needed for long-term care or infrastructure. These tensions do not defeat generative justice. They identify its normative dependence.

Proposition 24.354 (Generativity–justice separation). *Evidence that an arrangement generates or preserves capacities, opportunities, options, institutions, knowledge, or future possibilities does not by itself establish justice; a justice claim must additionally evaluate the identity, distribution, accessibility, burdens, foreclosures, and normative standing of what is generated or preserved.*

A further limit concerns attribution. Generative effects are frequently long-horizon and jointly produced. Justice analysis should not assign credit, responsibility, or entitlement to one visible generator when the outcome depends on public infrastructure, prior knowledge, ecological support, care, inherited institutions, or distributed maintenance. Generative justice therefore requires both normative and causal humility.

24.14.6 Conversion Justice

Section 24.11 treated value conversion as a mechanism-identification problem involving source and target forms, conversion conditions, interfaces, loss, gain, irreversibil-

ity, failure, power, and non-equivalence. Conversion justice asks a different question: whether the terms under which subjects can convert resources, status, knowledge, rights, recognition, time, or other value-bearing conditions into practically usable forms are just.

Definition 24.355 (Conversion-justice bridge). A *conversion-justice bridge* links a reconstructed conversion architecture to a justice judgment by recording eligibility, interface control, source and target forms, conversion conditions, losses, timing, burden, alternatives, residual value, reversibility, appeal, power, affected third parties, and the normative principle used to evaluate those terms.

Unequal conversion outcomes can be justice-relevant without being sufficient evidence of injustice. Outcomes can differ because needs, preferences, effort, context, technical conditions, or prior positions differ. Conversely, identical conversion rates can conceal injustice when the initial source holdings, burdens, access conditions, or background constraints differ sharply. The justice object is therefore the architecture of conversion rather than equality of one observed ratio alone.

Voluntariness also requires care. A formally chosen conversion can occur under severe dependence, absence of alternatives, misleading representation, or urgent need. Yet background constraint does not make every chosen conversion coercive or unjust. GRE should reconstruct effective alternatives, timing, information, power, and consequences rather than infer voluntariness or coercion from contractual form alone.

Proposition 24.356 (Conversion-outcome justice non-equivalence). *Neither equality nor inequality of observed conversion outcomes is sufficient to establish conversion justice; the judgment depends on the terms of access, control, burden, loss, alternatives, voluntariness, residual value, reversibility, and the normative principles governing the interface.*

Compensation creates a further limit. A successful conversion of money into a recognized compensation claim does not establish restoration of lost relational, ecological, historical, or future value. Section 24.10 preserved residual value under partial commensuration; conversion justice should therefore record the *non-equivalence remainder* rather than treating payment, replacement, or formal settlement as proof that justice has been fully achieved.

24.14.7 Intergenerational Justice

Intergenerational justice extends the justice horizon beyond currently participating positions. Chapter 16 described intergenerational generative inheritance as the capacities, constraints, ecological conditions, infrastructures, knowledge, institutions, obligations, relational structures, and revision possibilities transmitted across cohorts or generations. The justice limit is epistemic and representational as well as normative: future persons cannot generally state their preferences in current procedures, their identities and circumstances are only partly knowable, and current institutions can confuse preservation of present priorities with protection of future agency.

Definition 24.357 (Intergenerational representation profile). An *intergenerational-justice representation profile* records the future positions whose interests or standing are represented, the proxy or institutional mechanism used, the information available, temporal horizon, uncertainty, transmitted capacities and burdens, ecological and infrastructural conditions, reversibility, revision capacity, intragenerational dis-

tribution, and the normative principle authorizing present representation of future claims.

The representation problem creates two opposite risks. One is presentism: current actors discount or omit future burdens because future positions lack direct voice. The other is paternalistic projection: current actors define future welfare so strongly that they narrow later generations' capacity to revise inherited institutions and values. Generative justice suggests protecting revision capacity, knowledge, ecological resilience, institutional competence, and feasible alternatives where appropriate, but it cannot specify every substantive future good.

Temporal aggregation also conceals distribution. A policy that benefits "future generations" in aggregate can burden particular future regions, classes, occupations, or communities. Long-lived infrastructure can support future capability while locking in technical standards or debt. Ecological protection can preserve one capacity while constraining another. Intergenerational justice therefore requires both cross-generational and within-generation incidence.

Proposition 24.358 (Future-standing humility condition). *A GRE intergenerational-justice claim should protect justice-relevant future standing without presenting uncertain future preferences, identities, or institutional forms as if they were directly observed; where substantive future interests are uncertain, the analysis should state the proxy, preservation rule, reversibility, and revision capacity on which the present judgment depends.*

This condition does not imply indifference to foreseeable future harm. Long-lived pollution, debt, infrastructure lock-in, knowledge loss, or institutional destruction can be sufficiently well evidenced to support strong present obligations under an appropriate normative framework. The limit concerns unwarranted specificity, not responsibility.

24.14.8 Justice under Incommensurable Values

Section 24.10 rejected the assumption that heterogeneous values must either admit one common measure or become wholly incomparable. Justice analysis inherits this middle position. Distributional resources, recognition, autonomy, care, ecological conditions, future possibility, rights, historical repair, and relational standing can be jointly relevant while resisting reduction to one scalar metric.

Definition 24.359 (Non-scalar justice comparison). *A non-scalar justice comparison evaluates an economic arrangement through several normatively relevant value dimensions using explicitly stated thresholds, constraints, priority relations, rights, qualitative judgments, deliberative procedures, or partial orderings without asserting a complete common metric among those dimensions.*

Non-scalar comparison makes action possible without inventing false commensurability. A decision can reject an option because it violates a rights constraint even if the value of that right is not converted into money. A policy can be required to meet ecological and sufficiency thresholds before efficiency comparisons are considered. A deliberative body can judge that one residual loss is unacceptable without expressing the loss as a common unit with every benefit. These practices establish decision rules, not value identities.

The difficulty is that procedures themselves are normative objects. A lexicographic

priority, veto, threshold, majority rule, expert judgment, negotiated compromise, constitutional right, or multicriteria procedure is not neutral merely because it avoids scalar aggregation. Each determines which claims can override others, who has standing, and how unresolved remainder is treated.

Definition 24.360 (Justice-relevant residual disagreement). A *justice-relevant residual disagreement* is a material normative disagreement that remains after the descriptive facts, comparison procedure, and feasible alternatives have been clarified and that cannot be removed without adding, revising, or prioritizing a substantive normative premise.

Proposition 24.361 (Incommensurability non-paralysis). *Failure of complete commensurability does not imply that justice judgment or collective action is impossible, but any bounded decision procedure used in its place should disclose the normative priorities, exclusions, residual values, and authority relations through which action becomes determinate.*

The proposition also guards against forced commensuration. Institutions often need decisions, budgets, rankings, or eligibility rules. Practical determinacy can be necessary, but institutional necessity does not transform an imposed metric into a morally neutral measure of heterogeneous value.

24.14.9 Normative Underdetermination

The preceding subsections converge on a justice-specific form of normative underdetermination. A richly reconstructed economic configuration can remain compatible with several serious normative interpretations. Equality can conflict with priority; rights can constrain aggregate benefit; relational non-domination can conflict with paternalistic protection; historical repair can conflict with present claims; generative opportunity can conflict with stability or ecological restraint. GRE can make these conflicts more visible, but greater descriptive detail does not mechanically select one normative theory.

Definition 24.362 (Justice normative-underdetermination set). A *justice normative-underdetermination set* is the set of serious normative frameworks or premise combinations that remain compatible with the materially relevant descriptive and causal evidence in a scoped inquiry yet yield different justice judgments, priorities, or recommended actions.

The set should not be inflated by including every imaginable moral claim. A framework belongs in the serious set only when its premises are coherent enough for the inquiry, its standing and comparison rules can be stated, and its application to the case can be made intelligible. Nor does underdetermination imply that all frameworks are equally defensible. Internal inconsistency, factual misapplication, arbitrary exclusion, self-defeating principles, or conflict with domain-specific rights and obligations can weaken particular positions. The point is narrower: the economic facts alone do not guarantee one remaining normative conclusion.

Definition 24.363 (Normative divergence locus). A *normative divergence locus* is the specific premise, priority relation, standing rule, threshold, baseline, aggregation rule, or procedural authority at which otherwise shared empirical reconstruction produces materially different justice conclusions.

Locating the divergence is often more productive than searching for an artificial

consensus. Researchers can then distinguish disagreements about evidence from disagreements about moral standing, priority, responsibility, rights, or acceptable trade-offs. The result can also guide empirical work: some normative disagreements become less consequential when a feasible alternative dominates across several serious frameworks, while other disagreements remain decisive even after extensive factual clarification.

Proposition 24.364 (GRE normative non-derivation). *GRE's descriptive concepts of relation, generativity, capability, power, conversion, circulation, stability, option structure, or historical transmission do not by themselves derive a unique justice judgment; any such judgment requires normative premises whose role, scope, and revisability should remain explicit.*

A later section generalizes this limitation beyond justice theory to GRE's normative claims more broadly. The present subsection establishes the justice-specific implication: normative underdetermination should be represented as part of the analysis rather than concealed behind technical vocabulary or one unmarked evaluative default.

24.14.10 Transfer Justice

Transfer justice concerns discrete or staged movements of resources, claims, rights, obligations, access, recognition, support, or other value-bearing conditions among specified positions. Chapter 22 emphasized that formal sender and recipient are often insufficient to identify actual incidence. Transfers can pass through intermediaries, require conversion, alter dependency, affect third parties, impose administrative burdens, change local prices, generate later obligations, or interact with historical claims. The limitation is therefore a nominal-transfer fallacy: treating the declared amount or destination as if it exhausted the justice object.

Definition 24.365 (Transfer-justice limitation profile). *A transfer-justice limitation profile records the transferred object, formal sender and recipient, contributors and intermediaries where relevant, eligibility, conditions, timing, conversion steps, administrative burdens, direct and indirect economic incidence, relational and generative effects, affected third parties, historical context, return or recirculation, practical alternatives, and the normative principles used to evaluate the transfer.*

The distinction between transfer and repair is especially important. Compensation can improve material position while leaving a damaged relation, lost time, cultural loss, ecological damage, exclusion, or historical misrecognition substantially unaddressed. Conversely, symbolic recognition can matter while leaving material disadvantage untouched. A transfer can therefore be justified and beneficial without constituting complete repair, and repair can require institutional or relational change beyond transfer.

Proposition 24.366 (Transfer–repair non-equivalence). *Evidence that a transfer is adequate under a specified distributive or compensatory metric does not by itself establish that the underlying harm, relation, historical claim, lost capability, residual value, or future constraint has been adequately repaired.*

Conditional transfers create another limit. Conditions can support legitimate purposes such as verification, safeguarding, or coordination, but they can also impose surveillance, stigma, delay, behavioral control, or burdens that disproportionately reduce realized benefit. Universal and unconditional transfers are not automatically

superior either; they can misallocate scarce resources or fail to address differentiated need. Justice requires comparison among feasible architectures rather than a categorical preference for one transfer form.

Third-party incidence can also be decisive. A housing subsidy can partly accrue to landlords through price changes. Remittances can redistribute care and bargaining burdens within households. Aid can strengthen implementing organizations or procurement networks. Debt relief can alter creditor and taxpayer positions. A transfer justice analysis should therefore track not only who formally receives the transfer but who ultimately gains, pays, controls, converts, captures, and inherits its consequences.

Definition 24.367 (Transfer-justice remainder). *A transfer-justice remainder is any materially relevant justice claim concerning relation, recognition, participation, historical responsibility, residual value, third-party incidence, generative consequence, or future constraint that remains unresolved after the nominal transfer and its directly measured economic effects have been accounted for.*

Proposition 24.368 (Justice-theoretical limitation principle). *A GRE justice analysis should reconstruct economic structures precisely and state its normative premises explicitly; richer description does not eliminate normative underdetermination.*

The principle closes the section by locating GRE's distinctive contribution and its limit. GRE can reveal justice-relevant mechanisms that disappear in a purely distributive snapshot: conversion barriers, circulation capture, recognition power, relational dependence, generative foreclosure, intergenerational transmission, residual value, and transfer incidence. These additions can materially change a normative judgment. They do not, however, transform GRE into a complete moral theory. Justice remains a domain in which richer economic reconstruction and explicit normative reasoning must remain coupled without being conflated. The next section turns from this theoretical limit to practical action, where institutions must intervene under incomplete knowledge, unintended consequences, irreversibility, value conflict, participation constraints, limited capacity, and radical uncertainty.

24.15 Limits of Applied Praxis

Chapter 10 developed application-dominant praxis as consequential action undertaken when knowledge, values, institutional conditions, and future consequences can remain incomplete. Chapter 11 then developed methodologies for diagnosis, decision, intervention, monitoring, adaptation, repair, exit, and rollback. The present section returns to that practical architecture after the preceding Chapter 24 analyses of epistemic limitation, historical reconstruction, formalization, heterogeneous value, power, and justice. Its role is not to restate methods for choosing interventions. Its objective is to specify the conditions under which applied GRE can become practically overconfident even when its descriptive and formal work is internally careful. The analysis proceeds through incomplete knowledge, unintended consequences, irreversibility, model risk, value conflict, participation limits, institutional capacity, and action under radical uncertainty. The governing method is relational and consequence-sensitive: the quality of an intervention depends not only on the correctness of a proposed target but also on who bears uncertainty, what can be monitored, what can be repaired, which alternatives remain available, which institutions

Table 24.15: Principal limits of applied GRE praxis

Praxis problem	Characteristic overreach	Required GRE discipline
Incomplete knowledge	Urgency is treated as if it removes epistemic uncertainty	Match commitment to warrant, stakes, reversibility, monitoring, and consequences of delay
Unintended consequences	Unplanned effects are treated either as unforeseeable noise or as proof that intervention was mistaken	Reconstruct consequence pathways, adaptation, second-order effects, distribution, and learnability
Irreversibility	Formal rollback is equated with restoration of the prior practical state	Track material, institutional, relational, capability, ecological, and option-space irreversibility
Model risk	A useful model is treated as a sufficient practical representation of the intervention field	Record model purpose, omitted mechanisms, shared assumptions, decision sensitivity, and fallback pathways
Value conflict	One operational metric silently settles heterogeneous evaluative disagreement	Preserve protected values, residual disagreement, explicit priority rules, and revision authority
Participation limits	More participation is assumed to be always feasible, representative, or just	Match participation architecture to relevance, burden, capability, representation, power, and decision stage
Institutional capacity	A desirable intervention is assumed implementable because it can be specified	Test authority, competence, resources, coordination, monitoring, memory, repair, and continuation capacity
Radical uncertainty	Unspecifiable futures are converted into precise probabilities or used to justify arbitrary caution	Use robust, adaptive, reversible, plural, monitored, and revisable postures proportionate to stakes

can implement and revise the intervention, and which consequences of action or non-action become difficult to reverse.

Applied praxis creates a distinctive theoretical pressure because practical systems cannot always postpone commitment until research uncertainty has been resolved. Waiting can itself redistribute risk, preserve harmful trajectories, consume time, exhaust resources, normalize institutions, or foreclose later options. Yet urgency does not convert uncertainty into knowledge. The appropriate GRE response is therefore neither maximal caution nor maximal intervention by default. It is to connect the strength and reversibility of practical commitment to the quality of the available warrant, the severity and distribution of possible consequences, the capacity to observe and repair error, and the option structure retained after action.

Definition 24.369 (Applied-praxis limitation profile). An *applied-praxis limitation profile* records the practical objective, affected positions, evidential basis, unresolved uncertainty, serious rival interpretations, intervention mechanism, scale and timing, anticipated and unanticipated consequence channels, reversibility, repair capacity, value conflicts, participation architecture, institutional capability, monitoring conditions, non-action consequences, and reopening criteria that bound a GRE intervention claim.

The profile extends the limitation grammar introduced in Section 24.1. A limitation in applied praxis is not equivalent to a reason for paralysis. It identifies where practical responsibility requires additional safeguards, narrower claims, staged commitment, alternative designs, stronger monitoring, or explicit acceptance of residual risk. Conversely, the presence of an implementation mechanism or formal authorization does not establish that the intervention is adequate. Praxis remains answerable to what happens after authorization, including adaptation, feedback, third-party incidence, institutional degradation, and later inability to revise the arrangement.

Table 24.15 summarizes the principal limits developed below.

24.15.1 Incomplete Knowledge

Incomplete knowledge is ordinary rather than exceptional in application-dominant praxis. The practical system can be only partly observed; causal mechanisms can remain disputed; historical analogies can be imperfect; affected positions can be incompletely represented; future conditions can change during implementation; and the intervention itself can generate evidence that did not exist beforehand. Section 24.3 treated these as epistemic limits. The applied problem is different: a practical commitment must often be made while those limits remain active.

The first danger is an *urgency conversion error*: because delay has costs, the decision process silently treats the need to act as if it increased confidence in the favored model. Urgency can lower the practical threshold for commitment when delay itself is dangerous, but it does not strengthen the underlying evidence. A decision made under time pressure should therefore carry its residual uncertainty into implementation rather than retrospectively redescribing the decision as epistemically settled.

Definition 24.370 (Decision-relevant ignorance profile). A *decision-relevant ignorance profile* records the materially consequential unknowns, uncertain mechanisms, unobserved affected positions, unresolved rival explanations, unknown response elasticities, uncertain temporal horizons, and possible missing categories whose variation could alter the ranking, design, timing, or reversibility of candidate practical responses.

The profile is intentionally narrower than a catalogue of everything unknown. Applied praxis becomes impossible if every metaphysical or empirical uncertainty is treated as decision-critical. The relevant question is which unknowns could materially change the practical conclusion. Some uncertainties affect only a fine-grained estimate while leaving the direction of action stable. Others change whether the intervention should proceed at all, which population should be protected, or whether a supposedly reversible pilot can create durable lock-in.

Incomplete knowledge also creates an asymmetry between acting and waiting that must be made explicit rather than assumed. In some cases, intervention generates irreversible harm while waiting preserves alternatives. In others, delay allows preventable harm, institutional reproduction, ecological degradation, capability loss, or infrastructure deterioration to continue. Non-action can therefore require the same evidential and normative scrutiny as action.

Definition 24.371 (Action-inaction consequence symmetry). *Action-inaction consequence symmetry* is the analytical requirement that a practical comparison represent materially relevant consequences of intervention, delay, continuation, refusal, and withdrawal under comparable temporal, distributive, and uncertainty conditions rather than treating the status quo as consequence-free by default.

The requirement does not imply moral equivalence between action and omission. It prevents the analytical baseline from receiving an unearned presumption of harmlessness. A policy change can create risk, but so can retaining an arrangement known to generate exclusion or environmental damage. A delayed infrastructure repair can preserve fiscal flexibility while increasing the probability of later failure. A moratorium can preserve options while also concentrating costs on positions dependent on timely access. The practical comparison should therefore state what is expected to continue if no new intervention occurs.

Proposition 24.372 (Incomplete-knowledge commitment condition). *When con-*

sequential action cannot reasonably await complete knowledge, the warrant for commitment should depend jointly on the best available evidence, the consequences of delay or non-action, the stakes and distribution of plausible error, the reversibility of the commitment, the capacity for monitoring and repair, and explicit conditions for reopening the decision.

This proposition does not supply a universal decision formula. It specifies the dimensions that prevent incomplete knowledge from being converted either into false certainty or into indefinite postponement. The balance among them remains domain- and case-specific.

24.15.2 Unintended Consequences

Applied interventions act in relational systems whose participants adapt, interpret, resist, imitate, route around, or strategically use the intervention. Consequences can therefore arise outside the target mechanism even when the target mechanism is correctly specified. Price changes can redistribute benefits; eligibility rules can alter behavior; new infrastructure can change settlement patterns; a transparency rule can improve accountability while reducing candid internal deliberation; a safety requirement can create a compliance industry that later shapes the rule itself. Unintended consequences are not peripheral accidents. They are ordinary products of intervention into systems with feedback, heterogeneous positions, and changing relations.

The phrase nevertheless requires discipline. An unintended consequence is not simply any outcome the analyst failed to predict. The consequence can have been anticipated by affected participants but ignored by the decision authority. It can be foreseeable in kind but uncertain in magnitude. It can result from implementation failure rather than the intervention mechanism. It can be generated only after agents adapt to the policy. These cases carry different implications for responsibility and revision.

Definition 24.373 (Unintended-consequence profile). *An unintended-consequence profile records an intervention's non-target effects, the positions affected, causal or generative pathway, temporal delay, scale, distribution, foreseeability at the decision point, whether the effect was represented by dissenting or peripheral participants, the role of adaptation or strategic response, and the available mitigation, repair, or reversal pathways.*

The profile distinguishes unintended from unforeseen. A consequence can be unintended yet foreseen and accepted as a cost. It can be unforeseen by the authorized decision maker yet well understood by a local community. It can also be genuinely difficult to anticipate because the intervention changes the field in which later responses arise. This distinction matters for accountability. A system that repeatedly ignores known peripheral warnings has a different limitation from one that encounters a novel mechanism generated by the intervention itself.

A second limit concerns the interpretation of surprises. Unintended consequences do not automatically prove that the intervention was unjustified. A practically responsible intervention can generate an unforeseeable adverse effect despite proportionate safeguards. Conversely, a favorable surprise does not validate the decision process retroactively. Practical evaluation should distinguish the quality of ex ante judgment from the realized ex post outcome.

Definition 24.374 (Praxis surprise decomposition). *A praxis surprise decomposition*

separates an unexpected outcome into errors or omissions in prior evidence, model specification, problem framing, implementation, participation, institutional coordination, adaptive response, exogenous change, and genuinely emergent consequence pathways that became identifiable only after intervention.

This decomposition supports learning without encouraging hindsight bias. If a harmful consequence followed from a documented but disregarded warning, the correction concerns decision architecture or power. If it followed from a model assumption known to be fragile, the correction concerns model risk. If it emerged through a previously unavailable feedback loop, the correction may concern monitoring and adaptive capacity rather than culpable prior ignorance.

Proposition 24.375 (Unintended-consequence learning condition). *An unintended effect should revise GRE praxis when the reconstructed consequence pathway reveals a materially relevant mechanism, affected position, interaction, or adaptation that the prior intervention architecture omitted or misweighted; the required revision should target that omission rather than treating every surprise as either random noise or total failure of intervention.*

The proposition makes practical learning selective. Application can generate evidence, but the evidence becomes theoretically useful only when the pathway is reconstructed with enough specificity to alter later diagnosis, design, monitoring, or repair.

24.15.3 Irreversibility

Irreversibility raises the stakes of applied error because later knowledge can arrive after the relevant option has closed. Chapters 10 and 11 therefore treated rollback, option preservation, and adaptive revision as central practical capacities. Section 24.11 further distinguished irreversibility in value conversion. The present limit concerns intervention as a whole. A policy can be formally repealed while its infrastructural, ecological, institutional, relational, or capability effects persist.

Definition 24.376 (Practical irreversibility profile). *A practical irreversibility profile records which intervention effects can be undone, restored, compensated, substituted, or only partially repaired across material, ecological, institutional, legal, relational, informational, capability, financial, and option-space dimensions, together with the horizon and cost under which reversal remains feasible.*

The profile prevents formal rollback from being treated as restoration. A regulation can be revoked after firms have exited, skills have atrophied, infrastructures have been dismantled, or land use has changed. A platform can be replaced after network effects and data dependencies have reorganized an institution. A development project can compensate displaced persons without restoring lost social relations or ecological conditions. Reversibility is therefore multidimensional and position-dependent.

The opposite error is to treat every costly change as irreversible. High reversal cost can justify caution without establishing impossibility. Some effects can be repaired through time, investment, institutional redesign, or compensatory pathways. Others are irreversible within the horizon relevant to affected persons even if technically reversible over a century. The practical claim should therefore state the horizon and object of reversal.

Definition 24.377 (Reversibility reserve). *A reversibility reserve is the retained collec-*

tion of alternatives, resources, competencies, records, interoperable infrastructures, legal authority, exit rights, relationships, ecological buffers, time, and repair pathways required to suspend, redirect, replace, or substantially repair an intervention before materially relevant options close.

A reversibility reserve can decay during implementation. Staff leave, alternative suppliers disappear, debt accumulates, data migrate into proprietary systems, communities reorganize, sunk costs increase, and political constituencies form around the intervention. An initially reversible pilot can therefore become practically durable through accumulation rather than one explicit commitment.

Proposition 24.378 (Irreversibility-sensitive commitment principle). *As the severity, distribution, or irreversibility of plausible adverse consequences increases, responsible applied praxis should demand stronger warrant or stronger protective architecture, including staged commitment, retained alternatives, monitoring, repair capacity, or other mechanisms proportionate to the stakes; urgency can modify but does not erase this burden.*

The principle remains deliberately non-algorithmic. Inaction can itself be irreversible, especially under ecological degradation, epidemic growth, infrastructure failure, or rapid capability erosion. The relevant comparison concerns competing irreversibilities, not intervention irreversibility in isolation.

24.15.4 Model Risk

Section 24.7 examined formalization limits at the level of theory and model construction. Applied praxis adds another problem: even a useful, empirically supported model can create practical risk when it is used outside its validated purpose, embedded in an institution that changes behavior, or treated as more complete than the decision requires. Model risk therefore concerns the relation between representation and commitment rather than model error alone.

Definition 24.379 (GRE praxis model-risk profile). *A GRE praxis model-risk profile records the model's practical purpose, target and boundary, evidential support, omitted mechanisms, parameter and category uncertainty, relevant alternative models, shared assumptions across the model family, intervention sensitivity to model variation, performative effects of model use, monitoring signals, and fallback or override pathways.*

A model can be excellent for forecasting one variable and poor for selecting an intervention because intervention changes the process that generated the historical data. A model can rank candidates accurately on average while systematically under-representing a small group whose welfare is normatively protected. A simulation can clarify possible mechanisms while lacking enough calibration for quantitative policy thresholds. A causal estimate can identify a local average effect while providing limited guidance about a scaled intervention under changed institutions. Model quality is therefore purpose-indexed.

Reliance on multiple models does not automatically resolve the problem. Models can share data, categories, omitted variables, institutional assumptions, or common historical training conditions. Apparent agreement can therefore reflect correlated representational error rather than independent corroboration, as Section 24.4 already established for representations more generally.

Definition 24.380 (Decision-model dependence). *Decision-model dependence* is the degree to which a practical recommendation, intervention design, timing, target, or threshold changes under serious alternative model structures, parameterizations, boundary choices, or assumptions that remain compatible with the available evidence.

High dependence does not make action impossible. It changes the design problem. An intervention can sometimes be chosen because it performs acceptably across several serious models, because it is easily reversible, or because monitoring can discriminate among the models after a bounded pilot. In other cases, one model-dependent recommendation carries enough irreversible downside that additional inquiry is warranted.

Proposition 24.381 (Model-use non-sufficiency). *The existence of a formally coherent, empirically useful, or comparatively successful model does not by itself justify the practical commitment derived from it; applied warrant additionally depends on decision-model sensitivity, omitted consequence channels, stakes, reversibility, institutional use, and the capacity to detect and correct model-induced error.*

This proposition also applies to GRE itself. Relational, network, field, dynamical, or history-based representations can illuminate intervention design while remaining one family of representations among others. Applied praxis should not privilege them merely because they fit the book's conceptual vocabulary.

24.15.5 Value Conflict

Applied praxis often requires a decision before value conflict has been resolved. Sections 24.9–24.14 showed why heterogeneous value, partial commensurability, residual value, and normative underdetermination cannot be eliminated simply by improving measurement. In application, however, budgets must be allocated, infrastructure located, eligibility defined, risks accepted or rejected, and timing chosen. Practical determinacy is therefore necessary even when evaluative determinacy is unavailable.

The first limit is procedural concealment. An institution can convert a substantive value conflict into a technical threshold, score, cost-benefit ratio, optimization objective, or administrative rule and then present the result as if the normative conflict had disappeared. The procedure can be necessary and legitimate, but its practical necessity does not make its priorities neutral.

Definition 24.382 (Applied value-conflict register). *An applied value-conflict register* records the materially relevant value claims, affected positions, partial comparison relations, protected thresholds or rights, residual values, substantive disagreement, decision procedure, authority for setting priorities, burdens of compromise, and conditions under which the settlement should be reopened.

The register preserves a distinction introduced in Section 24.9: settlement does not necessarily equal resolution. A planning authority can select one route after public deliberation while disagreement about landscape, livelihood, heritage, ecology, cost, or future development remains. A health institution can adopt a triage rule without proving that all competing ethical principles have been reconciled. Applied praxis requires closure sufficient for coordinated action while retaining the genealogy of that closure.

Value conflict also complicates experimentation. A reversible pilot can reduce epistemic uncertainty while still imposing concentrated burdens on a subgroup. Treating participants as merely sources of information can therefore convert epistemic benefit into an unacknowledged distributive or justice cost. Experimental value should remain one value among others.

Definition 24.383 (Protected-value floor). A *protected-value floor* is an explicitly justified practical constraint below which a specified value, right, capability, ecological condition, safety condition, or relational standing is not to be traded for improvement in other represented objectives within the current intervention architecture.

Protected floors are not intrinsically absolute. Some can admit emergency exceptions; others may be legally or morally stringent. Their analytical role is to make non-substitutability explicit where the applied framework claims it, rather than letting an aggregate objective silently override every dimension.

Proposition 24.384 (Practical settlement transparency condition). *When applied praxis must act amid unresolved value conflict, the decision architecture should distinguish the values that were compared, protected, subordinated, deferred, or left residual from the institutional procedure that produced practical closure; operational settlement should not be represented as proof of complete normative resolution.*

This condition makes later revision possible. If circumstances change, the institution can identify which priority rule or protected floor produced the earlier decision rather than treating the implemented outcome as a self-validating precedent.

24.15.6 Participation Limits

Participation is central to application-dominant praxis because affected positions can contribute local knowledge, value claims, problem definitions, implementation knowledge, and contestation. Yet participation itself has limits. Universal direct participation can be infeasible; repeated consultation can impose substantial time and emotional burdens; technical issues can require specialized knowledge; confidential information can constrain disclosure; some affected persons may lack the capacity or opportunity for direct participation; and highly organized participants can dominate processes that appear formally open.

The first analytical mistake is therefore to equate more participation with better praxis without specifying the function that participation is meant to perform. Participation in problem framing differs from participation in evidence production, value articulation, design, authorization, implementation, monitoring, appeal, or revision. Different positions can have different relevant standing across these stages.

Definition 24.385 (Participation-function profile). A *participation-function profile* records the practical stage, participating and non-participating affected positions, purpose of participation, mode of representation, information and accessibility conditions, decision influence, burden, compensation where relevant, power asymmetries, dissent preservation, and available contestation or appeal pathways.

The profile protects against symbolic participation. Attendance at a meeting, submission of comments, or formal membership on an advisory body does not establish consequential influence. Conversely, lack of direct co-decision does not always establish exclusion. A specialized safety decision can legitimately rely on expertise while remaining answerable through transparency, oversight, appeal, or representation of

affected interests.

Participation can also create ****participatory burden****. Communities facing repeated projects or crises can be asked to supply testimony, local knowledge, unpaid translation, emotional labor, or legitimacy to institutions whose underlying authority remains unchanged. Marginalized positions can be required to repeatedly demonstrate harm that institutions could have monitored themselves. A participation architecture should therefore evaluate who bears the cost of making the system knowable.

Definition 24.386 (Participation-capacity gap). A *participation-capacity gap* is the difference between a position's formal opportunity to participate and its practical capacity to make relevant knowledge, interests, reasons, objections, or proposals consequential within the decision process.

The gap can arise from time, language, expertise, disability, geography, digital access, legal insecurity, care responsibilities, organizational resources, agenda control, intimidation, or uncertainty about whether participation will matter. It can therefore be partly an economic and power problem rather than a procedural one alone.

Proposition 24.387 (Participation proportionality condition). *Applied GRE should evaluate participation relative to the practical function, stakes, affectedness, knowledge distribution, capacity, burden, power, reversibility, and available forms of representation or contestation rather than using maximal participation or formal inclusion as a universal proxy for responsible praxis.*

The proposition allows differentiated participation without treating expert or institutional authority as self-justifying. It requires the architecture of inclusion and exclusion to be stated and defended in relation to the decision object.

24.15.7 Institutional Capacity

An intervention can be normatively attractive, empirically plausible, and formally coherent while failing because the responsible institution cannot implement, monitor, maintain, coordinate, finance, interpret, or revise it. Chapter 10 treated collective capability as relational and institutional rather than as the sum of individual competence. Applied limitation analysis therefore has to ask whether the organization that is expected to act actually possesses the configuration of capabilities on which the intervention depends.

Definition 24.388 (Applied institutional-capacity profile). An *applied institutional-capacity profile* records the authority, resources, personnel, expertise, coordination, infrastructure, information access, implementation channels, monitoring capability, institutional memory, maintenance, repair, conflict-management, legitimacy, learning, and revision capacities required to carry an intervention through its relevant practical horizon.

Capacity is task-relative. An institution can have strong analytical capability and weak implementation capacity, strong implementation and weak monitoring, or strong emergency response and weak long-horizon maintenance. Aggregate labels such as “state capacity” or “organizational capability” can therefore conceal the exact stage at which the intervention becomes infeasible.

Capacity can also be endogenous to intervention. A program can build institutional competence through learning, infrastructure, coordination, and trust. It can also con-

sume or degrade capacity by exhausting staff, creating fragmented systems, displacing local knowledge, or binding the institution to a provider it cannot later replace. Feasibility assessment should therefore consider both the capacity required at entry and the capacity generated or lost during operation.

Definition 24.389 (Institution–intervention capacity mismatch). An *institution–intervention capacity mismatch* occurs when an intervention’s requirements for authority, resources, coordination, implementation, monitoring, maintenance, repair, or revision materially exceed the responsible institution’s practical capabilities over the relevant horizon.

The mismatch is not always a reason to abandon the objective. It can motivate a smaller-scale intervention, staged implementation, capacity-building phase, simplified design, additional redundancy, external support, or transfer of responsibility. The key is that institutional capability becomes part of intervention design rather than an assumed background condition.

There is also a normative danger in capacity adaptation. Institutions can become more capable of implementing a harmful or unjust objective. Capacity is therefore not a master value. Its desirability depends on the actions, constraints, accountability, and purposes it enables.

Proposition 24.390 (Capacity-constrained praxis condition). *A practically justified intervention should be evaluated against the institutional capacity required not only to initiate it but also to monitor, maintain, contest, repair, revise, and, where relevant, discontinue it; where this capacity is absent, the intervention design or the institutional architecture should change before nominal authorization is treated as practical feasibility.*

This condition links capacity to responsibility. Institutions should not externalize foreseeable implementation failure onto affected positions while retaining the appearance that the policy itself was well designed.

24.15.8 Action under Radical Uncertainty

The preceding limits concern uncertainties that can often be represented through known alternatives, parameter ranges, scenarios, or model disagreement. Some practical situations are harder. Relevant mechanisms, future categories, actor types, technological possibilities, ecological thresholds, institutional reactions, or value conflicts can be only partly specifiable before action. The issue is not merely that probabilities are unknown. The set of relevant possibilities and the language in which they should be described can itself remain open, especially in the generative systems examined in Section 24.8.

Definition 24.391 (Radical practical uncertainty). *Radical practical uncertainty* is a condition in which materially relevant future states, mechanisms, categories, response types, or value implications cannot be specified with sufficient completeness and stability to support a determinate probabilistic decision model for the practical horizon at stake.

The definition should not be used whenever probabilities are inconvenient or data are sparse. Ordinary uncertainty, ambiguity, and model disagreement can often be analyzed directly. Radical uncertainty is a stronger claim about openness of the possibility or model space itself. It should therefore increase epistemic humility rather

than license arbitrary intuition.

Action under radical uncertainty cannot rely on one universal rule. Precaution can protect against irreversible harm yet freeze harmful incumbencies; experimentation can generate evidence yet expose vulnerable groups or create lock-in; diversification and reversibility can preserve alternatives yet weaken coordination or durable investment. The appropriate response therefore depends on the stakes and domain.

Definition 24.392 (Radical-uncertainty response portfolio). A *radical-uncertainty response portfolio* is a case-specific combination of robustness, reversibility, modularity, diversity, redundancy, staged commitment, protected thresholds, monitoring, institutional learning, option preservation, dissent retention, repair capacity, and reopening rules used to govern action when the relevant future possibility space cannot be confidently closed.

The portfolio is not a checklist whose maximum score identifies the best intervention. Its elements can conflict and impose costs. The analytical task is to state why particular safeguards matter for the case and which risks they address.

Radical uncertainty also requires separating ex ante decision quality from ex post outcome. Responsible judgment can produce a poor result, while reckless judgment can benefit from favorable luck. Evaluation should therefore examine both without collapsing one into the other.

Definition 24.393 (Praxis reopening trigger). A *praxis reopening trigger* is a pre-specified or newly recognized condition, such as unexpected harm, changed evidence, institutional incapacity, model breakdown, value conflict, new affected positions, altered alternatives, loss of reversibility, or changed external conditions, whose occurrence requires material reconsideration of the intervention rather than routine continuation.

Reopening triggers matter because budgets, contracts, infrastructures, reputations, and political commitments can make revision harder as implementation proceeds. Responsible praxis therefore builds reconsideration into implementation from the beginning.

Proposition 24.394 (Applied-praxis adequacy principle). *Responsible GRE praxis does not require certainty before action, but the strength and durability of practical commitment should remain proportionate to evidential warrant, plausible harm, irreversibility, value conflict, participation and institutional capacity, the consequences of non-action, and the ability to monitor, repair, revise, or reopen the intervention as the relational field changes.*

The principle gives Chapter 24's limitation architecture a practical role. Applied GRE should neither postpone consequential commitment indefinitely nor use the need for commitment to suppress uncertainty. What remains unknown, contested, or institutionally fragile should remain visible in implementation and revision. The next section applies this discipline to domain transfer, where economic concepts can mislead when exported without reconstruction by the receiving domain.

24.16 Limits of Cross-Domain Transfer

Chapter 23 developed a disciplined architecture for interfaces between GRE and neighboring domains. It distinguished outward portability from universalization,

inward contribution from conceptual capture, lexical recurrence from semantic equivalence, and shared empirical objects from domain-specific jurisdiction. The present section returns to those interface constructions from the perspective of limitation analysis. Its role is to identify where an economically useful concept, mechanism, or representation can become misleading when carried into history, governance, law, education, ecology, or artificial-intelligence studies without reconstruction by the receiving domain. The objective is not to discourage cross-domain inquiry. It is to specify the evidential and semantic burdens that must be satisfied before an economic construction is treated as portable. The analysis proceeds through six receiving domains, then develops false-generalization diagnostics and a domain-specific correction architecture. The governing method is asymmetrical in a deliberate way: GRE can propose a transferable analytical kernel, but the receiving domain retains authority over the constitution of its objects, admissible evidence, domain-specific values, standing rules, temporal scales, and correction standards.

Cross-domain transfer creates a distinctive limitation because apparent success can occur before conceptual adequacy has been established. An economic vocabulary can organize a new problem, generate a productive question, or reveal an overlooked mechanism while simultaneously distorting the receiving domain if its original semantics are preserved too strongly. Terms such as allocation, value, conversion, circulation, participation, constraint, power, institution, capability, and efficiency can all travel, but what counts as their object and warrant can change materially across domains. A useful transfer must therefore preserve enough structure to remain analytically informative while allowing enough reconstruction for the receiving domain to refuse, modify, or retype what was imported.

Definition 24.395 (Domain-transfer limitation profile). A *domain-transfer limitation profile* records the GRE construction proposed for transfer, its source-domain semantics and warrant, the receiving domain and problem, the portable analytical kernel, the receiving-domain reconstruction, changed or rejected assumptions, non-transferable components, translation losses, domain-specific remainders, correction authority, and conditions under which the transfer should be narrowed, retyped, or abandoned.

The profile converts cross-domain use from metaphorical borrowing into an accountable research relation. It also prevents repeated usefulness from being counted automatically as independent evidence for a general theory. If several receiving domains adopt a concept because they inherited the same GRE or GR vocabulary, the recurrence can remain designed rather than independently discovered. Chapter 23 treated this as a shared-origin problem in cross-domain generalization. The present section asks the narrower practical question: what can go wrong before any such generalization is attempted?

Table 24.16 summarizes the principal transfer risks developed below.

24.16.1 Economics to History

Economic analysis often contributes useful questions to historical inquiry. Allocation, scarcity, institutional incentives, distribution, labor organization, market formation, value conversion, and circulation can illuminate material conditions and relational transformations that purely event-centered narratives might understate. Yet the transfer becomes limiting when contemporary economic categories are projected

Table 24.16: Principal limits of cross-domain transfer from GRE

Receiving domain	Characteristic transfer error	Required discipline
History	Economic categories are projected backward or treated as historically invariant	Reconstruct historical categories, archives, temporal regimes, and formation processes before importing economic semantics
Governance	Allocation, incentives, or efficiency are treated as sufficient descriptions of authority and collective coordination	Reconstruct legitimacy, public authority, implementation, participation, and institutional response capacities
Law	Practical control or economic incidence is treated as equivalent to legal validity, status, entitlement, or obligation	Preserve constitutive legal categories and source-domain authority over legal interpretation
Education	Learning, formation, or educational quality is reduced to capability production, productivity, or economic return	Preserve educational aims, pedagogical relations, epistemic development, and domain-specific evaluative standards
Ecology	Ecological systems are represented primarily through human valuation, resource flows, or economic substitutability	Preserve biophysical constraints, ecological dynamics, non-economic value, irreversibility, and domain-specific standing questions
AI studies	Technical performance or model output is translated directly into economic agency, capability, dependence, or authority	Reconstruct technical conditions, system boundaries, deployment context, human mediation, verification, and domain-specific agency claims
Cross-domain generalization	Repeated vocabulary or apparent structural resemblance is treated as domain-independent identity	Test semantic, causal, evidential, temporal, and normative correspondence and retain failed transfers as evidence
Domain correction	Receiving-domain objections are treated as external commentary rather than revision pressure on GRE	Record correction provenance and propagate revisions to the GRE claims that materially depend on the failed transfer

backward as if their identity, boundaries, or causal roles were historically invariant.

The first problem is category anachronism. A historical record can contain transactions, labor, obligations, property-like relations, exchange ratios, or administrative accounts without thereby instantiating the same concepts of market, wage labor, ownership, household, enterprise, value, productivity, or economic subject that operate in a later institutional setting. The same lexical label can also persist while its legal, social, political, or religious constitution changes. Historical transfer therefore requires category reconstruction before economic comparison.

Definition 24.396 (Historical transfer reconstruction). A *historical transfer reconstruction* records the historical period and scale, contemporary categories used by relevant actors and institutions, later analytical categories introduced by the researcher, archival basis, missing-record conditions, legal and institutional constitution, temporal regime, and the bridge by which a GRE concept is mapped onto the historical object.

The bridge matters because historical evidence is itself selective. Surviving prices, contracts, tax records, account books, or administrative classifications can make some economic relations unusually visible while leaving household care, informal exchange, coercion, ecological dependence, ritual obligations, or unrecorded labor comparatively obscure. A transfer that follows only the archive's most quantified traces can therefore mistake documentary visibility for historical centrality.

Economic categories can also create retrospective causal compression. If a later institutional outcome is known, earlier relations can be redescribed as steps toward that outcome even when actors faced several plausible alternatives. The non-teleological discipline developed in Section 24.6 therefore applies directly to transfer. Economic explanations can identify material and institutional constraints without converting historical development into an optimization path or treating realized institutions as

necessary equilibria.

Proposition 24.397 (History-transfer adequacy condition). *A GRE construction transferred into historical inquiry is adequately warranted only when its object, category semantics, temporal scale, evidential basis, and causal role have been reconstructed for the historical setting rather than inferred from lexical similarity, surviving quantitative records, or the later existence of an economic institution.*

The condition permits comparative economic history while limiting retrospective economicization. A historical domain can accept the transferred question and reject the source-domain category, or retain the category while revising its mechanism. Such rejection is informative rather than a failure of interdisciplinarity.

24.16.2 Economics to Governance

Governance is another domain in which economic constructions travel easily. Incentives, resource allocation, transaction costs, capability, institutional capacity, information asymmetry, collective goods, and distributional incidence can all improve analysis of public action. The transfer becomes limiting when governance is reconstructed as if collective coordination were exhausted by incentive-compatible allocation among already specified actors and preferences.

Governance can involve authority, legitimacy, representation, administrative competence, public justification, conflict management, jurisdiction, participation, emergency power, rule revision, and institutional memory. These objects are economically consequential but are not constituted by economic consequences alone. An intervention can be efficient under a declared objective and still be politically illegitimate, legally unauthorized, administratively infeasible, or incapable of sustaining compliance and contestation.

Definition 24.398 (Governance transfer remainder). *A governance transfer remainder records governance-relevant properties not established by the imported GRE construction, including public authority, legitimacy, jurisdiction, representation, participation, administrative capability, procedural requirements, contestability, and institution-specific response dynamics.*

The remainder is especially important for allocation language. GRE can analyze who receives resources, which relations are strengthened, whose capabilities are expanded, and how burdens are distributed. Those findings can be essential to governance analysis. They do not determine who is entitled to decide, what institutional procedure is valid, or whether the allocation rule is legitimate.

The transfer can also fail dynamically. Economic models sometimes treat an institution as a stable rule environment within which agents respond. Governance inquiry may instead need to explain how the rule-making body itself learns, fragments, delays, competes across jurisdictions, loses capacity, or changes its objective. The fast-slow caution of Section 24.6 is relevant here: an apparently slow institutional layer can change quickly during crisis, while supposedly flexible economic behavior can be locked into infrastructure or legal obligations.

Proposition 24.399 (Governance-transfer non-exhaustion). *Economic incidence, incentive structure, allocation efficiency, or capability effects can establish important governance-relevant facts, but none of these findings alone establishes public authority, legitimacy, procedural adequacy, administrative feasibility, or justified collective rule.*

The proposition preserves a productive interface. GRE can diagnose consequences and mechanisms while governance analysis retains authority over the additional predicates that make collective rule a governance object rather than merely an allocation problem.

24.16.3 Economics to Law

The economic–legal interface creates particularly strong transfer temptations because legal relations often shape ownership, exchange, liability, contract, organization, labor, inheritance, finance, and public provision. GRE can analyze how legal arrangements alter capabilities, conversion interfaces, circulation paths, power, and distribution. The limit appears when these practical effects are treated as if they constituted legal validity or legal status.

Practical control and legal entitlement can diverge. A party can possess *de facto* control without valid title; a legal right can exist without effective practical capacity to exercise it; contractual language can create formal obligations while enforcement, interpretation, or public-law constraints alter its practical effect. Economic models that collapse these distinctions can misidentify both the legal object and the economic mechanism.

Definition 24.400 (Legal transfer dependency). *A legal transfer dependency exists when a GRE claim materially depends on a legal category, status, validity condition, right, duty, jurisdiction, remedy, or authoritative interpretation whose warrant is supplied by legal sources and methods rather than by economic evidence alone.*

The dependency should remain visible after incorporation. If the legal interpretation changes, the GRE claim built on it may require revision. This is not a defect. It is the appropriate consequence of using an externally warranted constitutive premise.

A second danger is functional replacement. If two legal forms produce similar economic effects under one observation window, an economic analysis can be tempted to treat them as equivalent. Yet legal forms can differ in standing, remedies, procedural protections, third-party effects, default rules, public-law constraints, or future interpretive possibilities. Economic equivalence under one outcome measure therefore does not establish legal equivalence.

Proposition 24.401 (Law-transfer authority condition). *When GRE imports or evaluates a legal category, economic evidence may establish incidence, incentives, practical control, distribution, or capability consequences, but legal validity, legal identity, authoritative interpretation, and legal obligation remain dependent on the relevant legal sources, institutions, and interpretive practices.*

The condition also limits normative overreach. An economically efficient legal arrangement is not thereby legally legitimate or normatively justified. Conversely, a legal rule with substantial economic cost can remain binding or justified for reasons not reducible to economic welfare. Cross-domain transfer should preserve these possibilities rather than force one domain’s evaluative grammar onto the other.

24.16.4 Economics to Education

Educational processes have obvious economic consequences. Education can influence capability, labor opportunity, innovation, social mobility, epistemic participa-

tion, institutional competence, and long-horizon development. GRE therefore has good reason to analyze educational relations as generative economic conditions. The transfer becomes limiting when educational aims are identified with economic capability production or when measurable economic return is treated as a sufficient proxy for educational value.

Education can involve understanding, judgment, curiosity, disciplinary formation, aesthetic and moral development, social participation, identity, interpretation, epistemic autonomy, and relations among teachers, learners, institutions, communities, and bodies of knowledge. Some of these objects have economic effects. Their educational quality is not established by those effects.

Definition 24.402 (Educational transfer remainder). *An educational transfer remainder records learning aims, pedagogical relations, forms of understanding, judgment, curiosity, epistemic autonomy, developmental conditions, disciplinary standards, and other educational qualities whose adequacy is not established by the economic capabilities or returns associated with them.*

The distinction is especially important when generativity is used. A learning environment can generate economically useful skills while narrowing curiosity, weakening judgment, excluding forms of knowledge, or creating dependence on externally supplied cognitive infrastructure. Conversely, an educational practice with low short-run market return can generate long-horizon intellectual, civic, cultural, or scientific capacities whose economic effects are indirect or uncertain.

The same caution applies to measurement. Completion rates, test scores, earnings, publication counts, or platform activity can function as manifestations of some educational processes while omitting others. Section 24.4's representation limits therefore constrain any transfer from measurable economic or administrative outputs back to claims about educational quality.

Proposition 24.403 (Education-transfer dual-warrant condition). *A GRE claim about educational generativity should distinguish the economic capabilities or consequences that GRE can analyze from the educational quality, learning, judgment, or developmental claims that require educationally appropriate evidence and evaluative standards.*

The dual warrant permits a strong economic analysis of education without reducing education to human-capital production. It also allows educational theory to correct GRE when an economically attractive intervention degrades the relations or capacities that constitute educational practice.

24.16.5 Economics to Ecology

Ecological transfer creates some of the most consequential limits because economic systems depend on material and ecological conditions while economic valuation can make those dependencies appear commensurable with other represented objectives. GRE improves on simple scalar valuation by allowing heterogeneous value, ecological constraints, non-commensurable remainders, and relational dependence. Even so, economic vocabulary can still overreach if ecological processes are reconstructed primarily through human benefits, resource flows, substitution possibilities, or institutional prices.

Ecological systems possess dynamics, thresholds, material constraints, metabolic relations, evolutionary histories, and irreversible changes that are not created by eco-

conomic recognition. Economic actors can ignore a biophysical constraint without removing it. A price can change without the ecosystem improving, and an ecosystem can deteriorate without producing an immediate price signal. Economic manifestation therefore remains only one access channel to ecological change.

Definition 24.404 (Ecological transfer boundary). An *ecological transfer boundary* identifies the point at which a GRE representation of ecological dependence, value, resource use, conversion, circulation, or constraint requires ecological premises concerning system dynamics, thresholds, material processes, species or habitat conditions, irreversibility, and other biophysical relations that economics cannot independently establish.

The boundary is not a division between nature and economy. Economic institutions can alter ecological conditions profoundly, while ecological change can reorganize economic possibility spaces. The point is epistemic and disciplinary: the causal and constitutive claims about ecological systems require ecological evidence and concepts appropriate to those systems.

A further danger concerns substitution. Even when two interventions yield similar economic value under a declared metric, their ecological effects can differ in reversibility, resilience, trophic relations, spatial distribution, or future option structure. Compensation elsewhere in the economic system does not automatically restore the affected ecological relation. Sections 24.9 and 24.10 therefore constrain ecological aggregation and commensuration.

Proposition 24.405 (Ecology-transfer non-substitution condition). *Economic compensation, price equivalence, or aggregate value replacement should not be treated as ecological restoration or ecological equivalence unless the relevant ecological relations, functions, thresholds, temporal dynamics, and irreversibilities are independently shown to support that inference.*

This condition permits economic analysis of environmental incidence while preserving ecological correction authority. It also prevents GRE's own heterogeneous-value language from becoming a way to name ecological values without doing the ecological work required to establish them.

24.16.6 Economics to Artificial-Intelligence Studies

Artificial-intelligence studies create a different transfer problem because technical objects can be rapidly incorporated into economic systems before their technical boundaries, failure modes, or human-machine divisions of labor are stable. GRE can analyze capability asymmetry, dependence, conversion of technical capability into economic capability, platform concentration, workflow integration, epistemic mediation, and institutional consequences. The transfer becomes limiting when technical performance is translated directly into claims about agency, autonomy, economic capability, authority, or dependence.

An AI system is not a single homogeneous causal object. Model architecture, training data, inference infrastructure, interfaces, retrieval systems, tool use, organizational workflow, permissions, human review, deployment environment, monitoring, and update procedures can all matter to observed performance. A benchmark result or model-level capability can therefore fail to describe the deployed system that produces the economic consequence.

Definition 24.406 (AI transfer decomposition). An *AI transfer decomposition* records the technical system boundary, model and infrastructure components, deployment configuration, human roles, permissions, data and tool access, verification architecture, organizational mediation, failure modes, and the specific bridge by which a technical capability is claimed to become economically consequential.

The decomposition protects against capability inflation. A system can perform a task under benchmark conditions while lacking the access, reliability, permissions, complementary resources, or organizational integration required for economic realization. Conversely, modest model-level improvements can produce large economic effects when deployment changes coordination, scale, or bargaining positions.

Agency language requires additional restraint. Functional selection or automated action can be economically consequential without settling consciousness, moral standing, legal personality, political membership, or philosophical agency. Similarly, institutional use of AI can redistribute practical authority without proving that legal or political authority has been delegated to the system itself.

Proposition 24.407 (AI-transfer bridge condition). *A transfer from technical AI evidence to a GRE claim about economic capability, dependence, power, participation, or institutional effect should identify the deployment and organizational mechanisms through which the technical property becomes economically consequential; technical performance alone does not establish the stronger economic or normative predicate.*

This condition gives AI studies continuing correction authority. Technical evidence can overturn an economic narrative that assumes capabilities the deployed system does not possess, while GRE can show how apparently modest technical properties become consequential through concentration, institutional design, access, or dependence.

24.16.7 False Generalization

The six domain interfaces reveal a common danger: a concept can travel successfully enough to appear general while the apparent generality is produced by shared vocabulary, selective examples, similar institutions, or redefinition of the receiving-domain object until it fits the source concept. Chapter 23 distinguished designed recurrence from discovered recurrence. Domain-transfer limitation analysis adds a more local question: how can a false generalization be recognized before it becomes part of GRE's theoretical vocabulary?

One warning sign is ****semantic stretching****. A concept is preserved by gradually weakening its meaning until almost any receiving-domain phenomenon qualifies. If allocation comes to mean any difference in conditions, value any significance, power any causation, institution any persistent pattern, or generativity any change, cross-domain recurrence becomes trivial. Portability purchased through semantic emptiness is not strong generalization.

A second warning sign is ****success-conditioned sampling****. Researchers can preferentially discuss domains where a GRE concept appears useful and treat failures as irrelevant edge cases. Yet failed transfers can reveal the exact assumptions that make a concept economic rather than general. They are therefore comparative evidence and should remain visible in the transfer portfolio.

Definition 24.408 (False-generalization profile). A *false-generalization profile* records

lexical recurrence, source-domain dependence, shared conceptual ancestry, semantic stretching, selective case inclusion, receiving-domain reconstruction, failed transfers, counterexamples, non-transferable assumptions, historical variation, and whether the proposed cross-domain structure retains enough content to discriminate among alternatives.

False generalization can also arise from formal resemblance. Two domains can admit similar graphs, operators, optimization problems, dynamical structures, or category-theoretic representations without sharing causal mechanisms or ontological commitments. Section 24.7's mathematical-transfer discipline therefore applies directly. Structural similarity warrants a comparative question, not automatic mechanism identity.

Proposition 24.409 (Cross-domain generalization burden). *A GRE construction should receive stronger cross-domain status only when its recurrence survives receiving-domain reconstruction, meaningful semantic constraints, serious counterexamples, failed-transfer analysis, historical variation where relevant, and comparison with alternative structures that could explain the apparent recurrence.*

The burden is intentionally demanding because a future GRT should not be produced by exporting GRE vocabulary and then counting its reappearance as confirmation. Cross-domain comparison becomes informative when receiving domains can genuinely resist the transfer.

24.16.8 Domain-Specific Correction

Cross-domain transfer becomes epistemically productive only when the receiving domain can correct the source framework. Otherwise GRE can borrow examples and vocabulary while retaining authority over every interpretation. The limitation perspective therefore requires a failed or revised transfer to propagate back into the GRE claim that materially depends on it.

A receiving domain can reject the transferred object, narrow its scope, revise its semantics, identify a missing constitutive condition, supply counterevidence, distinguish collapsed mechanisms, or require an external normative warrant. Such correction need not revise GRE globally; the appropriate unit is the materially dependent claim.

Definition 24.410 (Domain-correction propagation record). *A domain-correction propagation record identifies the receiving-domain correction, its evidential or conceptual basis, the transferred GRE construction affected, the downstream GRE claims that materially depend on it, unaffected claims, required retyping or narrowing, and the conditions under which the revised transfer could later be reconsidered.*

The record prevents both insulation, in which criticism is acknowledged without altering the economic claim, and indiscriminate collapse, in which one failed transfer is treated as refuting unrelated GRE analyses. Dependency-sensitive revision avoids both errors.

Correction authority should be linked to the kind of claim at issue rather than to disciplinary prestige. Ecological, legal, educational, or technical premises remain answerable to the domains that can warrant them, while GRE remains responsible for how those premises are transformed into economic analysis.

Definition 24.411 (Cross-domain correction authority). *Cross-domain correction*

authority is the claim-specific responsibility of a receiving domain to evaluate the objects, evidence, semantics, mechanisms, or normative warrants that fall within its problem-space, together with GRE's responsibility to revise economic conclusions when those externally warranted premises materially change.

Correction authority does not create disciplinary veto over every mixed-domain claim. Many questions are genuinely joint. Its purpose is to prevent GRE from treating economic consequences as sufficient warrant for predicates constituted elsewhere.

Proposition 24.412 (Revisable domain-transfer principle). *Cross-domain transfer in GRE should remain typed, provenance-preserving, and revisable: the source framework may propose analytical kernels and economic consequences, the receiving domain retains authority over domain-specific constitution and warrant, and corrections should propagate to the GRE claims that materially depend on the transferred premise without requiring either disciplinary absorption or indiscriminate theoretical collapse.*

A transfer is not successful because GRE can describe another domain in its own language. It is successful when the borrowed construction survives receiving-domain reconstruction, remains open to correction, and makes failed transfers informative about GRE's boundaries. The next section applies this discipline to AI-era conditions, where technical change, opacity, concentrated infrastructure, epistemic dependence, and shifting capability boundaries can destabilize both transfer and internal GRE diagnosis.

24.17 AI-Era Limits

Chapters 17 and 18 examined artificial intelligence as part of the epistemic economy, artificial productive capacity, capability asymmetry, dependence, ownership, participation, and long-horizon economic order. Chapter 23 then placed GRE in an explicit interface with artificial-intelligence studies, preserving technical, economic, legal, political, educational, social, ethical, and ontological questions as separately warranted even when they are mutually conditioning. The role of the present section is different. It asks where the rapid incorporation of artificial systems creates limits for GRE's own claims, representations, and practical recommendations. The objective is not to treat artificial intelligence as uniquely unknowable or historically unprecedented. It is to identify a configuration in which technical capabilities, deployment architectures, verification burdens, human skills, synthetic representations, organizational routines, and institutional rules can change quickly enough that an economically adequate description becomes unstable while it is being used. The analysis proceeds through capability asymmetry, epistemic dependence, model opacity, delegated judgment, synthetic evidence, accelerated theory production, attention and orientation, and institutional dependence. The governing method is trajectory-sensitive: an AI-era GRE claim should specify not only the observed configuration but also which parts of that configuration are version-dependent, institution-dependent, capability-dependent, or vulnerable to rapid reclassification.

The AI-era limitation is therefore partly a problem of moving analytical boundaries. A model that is non-substitutable in one period can become widely available later. A workflow that appears to preserve human expertise can gradually externalize intermediate judgment. A proprietary infrastructure can become a practical bottleneck even while model-level competition increases. Verification procedures can lag behind

Table 24.17: Principal AI-era limits for GRE analysis

Limitation domain		Characteristic analytical risk	Required discipline
Capability asymmetry		Technical performance is treated as a stable measure of economic capability or power	Reconstruct access, complements, substitution, persistence, infrastructure, and capability trajectories
Epistemic dependence		Current performance gains obscure loss of verification, reconstruction, or fallback capacity	Track retained human and institutional epistemic agency across repeated use
Model opacity		Limited system intelligibility is treated either as total unknowability or as irrelevant to consequential use	Identify the source of opacity, consequence-specific evidence needs, and compensating controls
Delegated judgment		Automated recommendation or execution is treated as transfer of responsibility, authority, or normative warrant	Separate task delegation, judgment delegation, institutional authority, accountability, and retained challenge capacity
Synthetic evidence		Generated, simulated, reconstructed, or transformed artifacts acquire evidential standing through surface plausibility	Type the artifact, preserve provenance, verify the evidential bridge, and prevent circular validation
Accelerated production	theory	High-throughput hypothesis and formal production is treated as proportional growth in warranted theory	Preserve source verification, derivational completeness, discrimination among rivals, and independent empirical testing
Attention and orientation		Abundant outputs widen the candidate field while narrowing practical attention around machine-mediated rankings or framings	Track visibility, filtering, agenda formation, orientation diversity, and excluded alternatives
Institutional dependence		AI becomes embedded in workflows faster than substitution, audit, preservation, procurement, or governance capacity develops	Reconstruct stack-level dependence, concentration, exit, continuity, institutional memory, and adaptation lag

symbolic production. Institutional rules can stabilize around a technology whose capabilities and failure modes continue to change. These processes do not imply one inevitable direction. They create a stronger burden to separate current performance from retained capability, present dependence from future substitutability, technical opacity from institutional unaccountability, and rapid production from warranted knowledge.

Definition 24.413 (AI-era limitation profile). An *AI-era limitation profile* records the artificial systems and supporting infrastructures relevant to a GRE claim, their version and deployment context, affected human and organizational capabilities, verification and fallback arrangements, dependency and concentration structure, institutional rules, expected rates of change, and the conditions under which the economic interpretation should be retested, narrowed, or withdrawn.

Definition 24.413 prevents an AI-related economic conclusion from being detached from the technical and institutional configuration that made it true. It also clarifies why statements about “AI” often age badly: the named object can conceal a changing stack of models, interfaces, retrieval systems, data pipelines, compute, human review, organizational practice, legal permissions, and infrastructure providers. A limitation analysis therefore has to preserve enough configuration detail for later re-epistemization.

Table 24.17 summarizes the eight limitation domains developed below.

24.17.1 Capability Asymmetry

Capability asymmetry was developed earlier in the book as a multidimensional and relational condition rather than as a benchmark ranking. The AI-era limit arises because the relevant capability boundary can move rapidly and because capability

becomes economically consequential only through a surrounding conversion architecture. Technical performance, model access, compute, data, organizational integration, complementary human skill, legal permission, verification, and institutional standing can change at different rates. A static comparison can therefore misidentify both the location and durability of asymmetry.

Definition 24.414 (AI capability-boundary volatility). *AI capability-boundary volatility* is the degree to which the tasks, quality thresholds, costs, access conditions, complementary requirements, and substitution possibilities relevant to an AI-mediated economic capability change within the horizon of the GRE claim.

A volatile boundary complicates statements such as “AI can perform task X” or “position A has an AI advantage over position B.” Performance may depend on a particular model version, retrieval configuration, tool chain, prompt protocol, data environment, latency tolerance, human reviewer, or price. A capability that is economically significant at one threshold can be irrelevant at another. Conversely, a modest technical improvement can have large economic effects where it crosses an institutional acceptance threshold or eliminates a bottleneck.

Proposition 24.415 (Capability-asymmetry revalidation condition). *An AI-related capability-asymmetry claim requires revalidation when material changes in technical performance, access, complementary resources, substitution, verification, infrastructure, or institutional acceptance alter the pathway by which the capability becomes economically consequential.*

The proposition makes capability asymmetry historical. A previously concentrated capability can diffuse while dependence remains because workflows and records have become provider-specific. A widely accessible model can coexist with concentrated compute, data, distribution, or organizational integration. An apparent technical equalization can therefore leave the economic field highly asymmetric at another layer.

This is also where human skill complementarity and atrophy enter the analysis. AI use can increase a person’s practical capability by supplying translation, search, drafting, simulation, coding, or critique. Repeated use can also externalize some intermediate skills. These trajectories can coexist: a researcher may lose speed at unaided routine coding while gaining broader capacity for experimental design. The relevant limit is not whether skill has simply risen or fallen, but whether the capability profile required for later verification, adaptation, independent reconstruction, and participation remains adequate.

Definition 24.416 (Human–AI capability trajectory profile). *A human–AI capability trajectory profile* records, across repeated use, which human capabilities are complemented, newly generated, externalized, weakened, retained for verification, or made dependent on particular artificial and infrastructural supports, together with the consequences for later substitution and independent action.

A present productivity gain therefore cannot establish a favorable long-horizon capability trajectory. Nor does observed deskilling establish net capability loss where new higher-order capacities are generated. GRE should keep current output, distributed capability, retained fallback, and future learning as separate objects.

24.17.2 Epistemic Dependence

AI-mediated epistemic dependence arises when economically consequential functions of retrieval, synthesis, interpretation, classification, generation, or inference become difficult to perform, verify, contest, or reconstruct without artificial support. Earlier chapters emphasized that such dependence can be productive specialization rather than a defect. The limit emerges when present performance becomes easier to observe than the retained capacity required for later challenge and recovery.

The production of candidate outputs can scale more rapidly than human or institutional capacity to verify them. Chapter 17 described this as a relocation of scarcity under epistemic abundance. In AI-mediated settings the gap can become especially consequential because generation and verification have different cost structures. Fluent outputs can be produced quickly while source checking, replication, domain interpretation, and accountability remain comparatively slow. Symbolic abundance can therefore increase rather than reduce the economic value of provenance, trusted institutions, and verification capacity. Simon's analysis of information-rich environments remains relevant because abundance can intensify scarcity in the attention required to process available information (Simon 1971).

Definition 24.417 (AI verification-capacity gap). An *AI verification-capacity gap* is a persistent difference between the scale, speed, or complexity of AI-mediated claims entering an economically consequential process and the practical human or institutional capacity available to check their provenance, standing, assumptions, failure conditions, or consequences at the level required by that process.

The definition is intentionally process-relative. A brainstorming system can tolerate a wide gap because unverified outputs may remain provisional. A clinical, legal, scientific, financial, or public-administrative function can require much stronger verification. The same model can therefore generate different dependence risks across uses.

Proposition 24.418 (Epistemic performance and agency). *Improved AI-mediated epistemic performance does not establish preserved epistemic agency if reliance materially reduces access to sources, alternative interpretations, consequential verification, contestation, process reconstruction, or continuation under plausible changes in support.*

The proposition also guards against a simplistic autonomy ideal. No complex epistemic system is fully self-sufficient. The relevant question is which capabilities must remain distributed across humans, organizations, professions, public bodies, and technical infrastructures for the function to remain contestable and recoverable. The answer can differ by consequence and by institutional design.

A further limit concerns dependence measurement. Usage frequency is not sufficient. High-frequency use can remain weak dependence when alternatives are cheap and records are portable. Occasional use can create strong dependence when a rare AI-mediated function is a non-substitutable bottleneck. GRE should therefore evaluate verification, substitution, exit, reconstruction, and continuity rather than infer dependence from adoption alone.

24.17.3 Model Opacity

Model opacity is often discussed as if it were one property. For GRE, that treatment is too coarse. Opacity can arise from technical complexity, inaccessible training or

system information, proprietary restrictions, rapidly changing versions, interaction among multiple components, stochastic behavior, undocumented human procedures, or the difficulty of interpreting which internal feature matters for a particular outcome. Burrell's analysis is useful precisely because it distinguishes several sources of opacity rather than treating algorithmic inscrutability as a single condition (Burrell 2016).

Definition 24.419 (Consequence-relative opacity profile). A *consequence-relative opacity profile* records which parts of an AI-mediated process are inaccessible, unintelligible, unstable, or difficult to reconstruct; the source of each opacity; the economic consequence for which understanding is required; available behavioral, documentary, provenance, monitoring, audit, or contestation evidence; and the residual uncertainty that remains after those compensating measures.

This profile prevents two symmetrical errors. One is to conclude that an opaque model is unusable because complete internal understanding is unavailable. The other is to conclude that internal opacity is irrelevant whenever average performance is adequate. The relevant burden depends on what the system is allowed to do, what harms or dependencies are plausible, whether affected positions can challenge outcomes, and whether behavior can be reconstructed after failure.

Documentation and provenance can reduce some forms of opacity without revealing every internal mechanism. Datasheets and related documentation practices illustrate how structured information about data and system context can improve accountability without pretending to provide exhaustive understanding (Gebru et al. 2021). Audit can likewise test declared properties and institutional use without requiring complete transparency. Kroll and colleagues emphasize that accountability can depend on verifiable properties and procedural mechanisms rather than on a single ideal of explanation (Kroll et al. 2017).

Proposition 24.420 (Opacity compensation limit). *Behavioral testing, documentation, provenance, monitoring, audit, and contestability can compensate for some consequence-relevant opacity, but they do not eliminate residual uncertainty when material failure conditions, update effects, or deployment interactions remain outside the evidence inspected.*

Opacity therefore becomes a GRE limit when the institution's confidence or delegation exceeds what its evidence can support. The relevant remedy can be narrower use, stronger monitoring, redundant pathways, independent review, or retained human expertise rather than universal disclosure.

24.17.4 Delegated Judgment

Artificial systems can be incorporated into activities previously described as human judgment: ranking applicants, detecting anomalies, recommending treatments, allocating attention, drafting legal or policy analysis, selecting research questions, assessing risk, or proposing strategic action. The phrase *delegated judgment* can nevertheless conceal several distinct arrangements. A system may execute a pre-specified rule, generate options, rank alternatives, supply evidence, recommend an action, or trigger an action automatically. These arrangements differ in what has been delegated and in what remains institutionally human-governed.

Definition 24.421 (AI judgment-delegation profile). An *AI judgment-delegation profile* records the epistemic or practical function assigned to the artificial system, the

decisions or intermediate judgments retained by human or institutional positions, the source of governing criteria, review and override conditions, affected parties, responsibility allocation, records required for reconstruction, and the authority capable of revising the delegation.

The profile separates task execution from authority. A model can rank cases while a public body retains legal authority. A decision can be formally human-signed while practical judgment has migrated to an automated recommendation that reviewers rarely challenge. Formal location of authority and effective location of judgment can therefore diverge.

Proposition 24.422 (Delegation–authority non-equivalence). *Delegating an epistemic or decision-support function to an AI system does not by itself transfer legal authority, political legitimacy, moral responsibility, or normative warrant to the system, while nominal retention of authority by a human institution does not establish meaningful retained judgment when challenge and override are practically ineffective.*

This distinction is especially important for economic analysis because institutional actors can externalize labor or cognitive effort while retaining responsibility, or retain formal responsibility while losing practical capacity to supervise the delegated function. The latter creates a supervision paradox: the more an institution depends on AI for a function, the harder it can become to retain the expertise needed to evaluate that function independently.

Definition 24.423 (Delegation supervision gap). *A delegation supervision gap exists when the practical expertise, time, evidence, access, or institutional authority available to review an AI-mediated judgment is insufficient relative to the consequence of the delegated function and the plausible ways in which that function can fail.*

The gap can persist even with a nominal human-in-the-loop. Human presence is not equivalent to consequential review. GRE should therefore ask whether the reviewer can access relevant evidence, understand the decision context, disagree without excessive cost, and trigger correction.

24.17.5 Synthetic Evidence

AI-era symbolic abundance makes the evidential status of generated, simulated, reconstructed, or transformed artifacts a central limitation. Synthetic material can be legitimate and useful. Simulation can test hypotheses; generated examples can support training; reconstructed images can aid communication; transformed records can improve accessibility; synthetic data can protect privacy or explore scenarios. The danger arises when a representation enters an evidential chain without preserving the distinction between observation, simulation, illustration, reconstruction, transformation, and independently supported claim.

The earlier symbolic-abundance analysis emphasized that fluent output does not establish epistemic warrant (Bender et al. 2021). Provenance standards can help establish origin or transformation history without proving substantive truth (Coalition for Content Provenance and Authenticity 2026). Chapter 24’s manifestation and representation analysis adds a further point: a synthetic artifact can become causally consequential through institutional uptake even when its descriptive standing is weak. Its performativity should therefore be analyzed separately from its evidential adequacy.

Definition 24.424 (Synthetic-evidence typing record). A *synthetic-evidence typing record* identifies an artifact as observation, measurement, simulation, generated example, reconstruction, transformation, illustration, imputation, or another declared type; records its provenance and production process; states the claim for which it is being used; and specifies the evidential bridge connecting the artifact to that claim.

The record is necessary because a plausible artifact can be epistemically valuable without being observational evidence. A simulation can support reasoning about a model's implications. It cannot by itself establish that the modeled mechanism exists in the world. A reconstructed historical image can illustrate a plausible scene without becoming an archival record of that scene.

Proposition 24.425 (Synthetic-evidence non-circularity condition). A *synthetic artifact* does not independently corroborate the assumptions, model, or source material from which it was generated unless the evidential chain contains information or tests that are sufficiently independent of those generative inputs to discriminate among relevant alternatives.

This proposition is especially important where generated summaries, evaluations, or synthetic datasets are reused in later AI-assisted research. Repeated transformation can create the appearance of multiple supporting artifacts while their informational ancestry remains highly dependent. GRE should therefore preserve provenance and independence structure alongside content.

24.17.6 Accelerated Theory Production

Artificial systems can accelerate literature search, synthesis, coding, formal derivation, counterexample generation, model comparison, visualization, drafting, and production of candidate hypotheses. This can enlarge research possibility. It can also create a new imbalance between the rate at which theory-like objects are produced and the rate at which they can be verified, historically situated, empirically discriminated, or conceptually integrated.

Definition 24.426 (Theory-production verification gap). A *theory-production verification gap* is a sustained difference between the rate at which candidate concepts, hypotheses, formalisms, models, explanations, or manuscripts can be produced through AI-assisted inquiry and the capacity available to verify sources, reconstruct derivations, test assumptions, compare serious rivals, inspect counterexamples, and accumulate independent evidence.

The gap does not imply that rapid theory production is undesirable. It changes the bottleneck. Where candidate generation becomes cheap, discrimination and integration become more valuable. A research programme can accumulate many elegant constructions while increasing rather than reducing uncertainty about which constructions deserve retention.

Proposition 24.427 (Accelerated-theory warrant condition). *The epistemic standing of an AI-assisted theoretical construction depends on the warrant supplied for its premises, derivations, domain correspondence, rival discrimination, and empirical or interpretive support, not on the speed, fluency, formal sophistication, or volume with which candidate constructions can be generated.*

For GRE this condition has a direct methodological consequence. AI assistance can be especially productive for exploring formal alternatives, finding hidden assump-

tions, stress-testing definitions, checking notation, or generating candidate counterexamples. Yet every non-trivial formal object still requires locally defined semantics and every external claim still requires verified support. Accelerated production therefore increases the importance of provenance and versioning. Without them, it becomes difficult to reconstruct which insight originated in evidence, which was introduced as a heuristic, which arose from a model analogy, and which was later strengthened through independent research.

Definition 24.428 (AI-assisted theory provenance record). An *AI-assisted theory provenance record* preserves, at a level proportionate to the claim, the source materials, researcher judgments, AI-assisted transformations or candidate generation, subsequent verification, discarded alternatives, and evidence through which a theoretical construction acquired its present status.

The purpose is not to preserve every token or conversational step. It is to keep the intellectual and evidential dependencies of consequential claims reconstructible.

24.17.7 Attention and Orientation

AI-mediated abundance can widen access to candidate ideas while simultaneously reshaping which ideas become practically visible. Search systems, recommendation systems, conversational interfaces, generated summaries, ranking models, and automated research assistants all participate in attention allocation. The limitation is not only distraction or information overload. It concerns orientation: which questions, alternatives, literatures, examples, and causal framings enter the practical field of inquiry in the first place.

Attention is finite even when symbolic supply expands. Simon's scarcity argument therefore becomes more consequential rather than less consequential in high-output environments (Simon 1971). Ranking and classification can also become performative when visibility changes later behavior, investment, citation, or institutional recognition. Earlier work on rankings shows that public measures can reshape the organizations they evaluate rather than merely describe them (Espeland and Sauder 2007). AI-mediated orientation can generate analogous feedback where model-mediated salience influences which objects later accumulate evidence, resources, or attention.

Definition 24.429 (AI-mediated orientation profile). An *AI-mediated orientation profile* records the systems and interfaces through which candidate questions, sources, options, or interpretations become visible; ranking and filtering criteria; user and institutional feedback; excluded or weakly represented alternatives; diversity of orientation pathways; and the later consequences of repeated exposure for inquiry and action.

The profile prevents a common inference: broad access to an AI system does not imply broad practical exposure to the full possibility space. Users can have technically open access while converging on similar framings because interface defaults, ranking procedures, training distributions, organizational templates, or imitation dynamics narrow orientation.

Proposition 24.430 (Orientation-diversity condition). *AI-mediated inquiry preserves a wider practical orientation space when consequential positions retain access to plural sources, alternative framings, contestable ranking pathways, independent search or observation, and institutional opportunities to introduce questions or evidence not*

privileged by the dominant interface.

This proposition does not imply that maximal diversity is always efficient or epistemically superior. Orientation requires selection. The limit arises when the selection architecture becomes difficult to observe or contest while its outputs are treated as neutral representations of relevance. GRE should therefore analyze attention and orientation as allocative and generative processes, not merely as user preferences.

24.17.8 Institutional Dependence

The final limitation concerns the institutional embedding of artificial capability. An organization can become dependent on a model provider, cloud infrastructure, specialized chips, retrieval service, data pipeline, identity system, proprietary interface, or externally maintained workflow. Dependence can arise even when individual components are technically substitutable because records, skills, contracts, organizational routines, compliance procedures, or user expectations have adapted around the incumbent stack.

Definition 24.431 (Institutional AI dependence stack). *An AI institutional-dependence stack records the technical, infrastructural, contractual, legal, human-skill, organizational, and archival dependencies required for an institution to continue an AI-mediated function at the level relevant to its mandate.*

The stack makes concentration analytically layer-specific. Model plurality does not establish infrastructural plurality if several models rely on the same compute or cloud providers. Open model weights do not establish institutional independence where deployment requires scarce hardware, proprietary data, restricted interfaces, or specialized operational competence. Conversely, concentrated infrastructure does not prove domination unless the relevant control and dependence mechanisms are established under the power discipline of Section 24.13.

A second limit is institutional adaptation lag. Technical capabilities and interfaces can change more rapidly than procurement cycles, professional standards, educational curricula, audit procedures, legal rules, public budgeting, archival practices, or organizational learning. The resulting mismatch can produce two symmetrical failures: institutions can prohibit useful capabilities based on obsolete risk models, or institutionalize fragile systems before adequate verification and fallback structures exist.

Definition 24.432 (AI institutional adaptation lag). *AI institutional adaptation lag is the consequential temporal difference between changes in AI-mediated capability or deployment conditions and the capacity of relevant institutions to update rules, skills, records, verification procedures, infrastructures, participation arrangements, and accountability mechanisms.*

Adaptation lag is not always undesirable. Deliberate institutions can justifiably move more slowly than technical markets where consequences are difficult to reverse. The analytical question is whether the lag protects important values and learning, or instead leaves the institution governed by assumptions that no longer match its actual dependencies and risks.

Proposition 24.433 (Institutional-dependence vulnerability condition). *AI-mediated institutional dependence becomes more consequential when a function is economically or publicly important, the supporting stack is weakly substitutable, internal verifica-*

tion or reconstruction capacity is thin, exit is costly, critical records or skills are not preserved, and institutional adaptation is slow relative to material changes in the supporting systems.

These conditions do not imply that every institution should internalize its entire AI stack. Specialization can be efficient and robust. The relevant design question concerns where fallback, portability, auditability, institutional memory, contestability, and alternative providers or pathways are required by the consequence of the function.

Definition 24.434 (AI-era GRE validity horizon). *An AI-era GRE validity horizon is the declared period and configuration range within which an AI-related GRE claim is expected to remain warranted absent material changes in capability boundaries, deployment architecture, dependency, verification, human skill, institutional rules, or relevant neighboring-domain findings.*

Proposition 24.435 (AI-era revalidation principle). *AI-related GRE claims should be revalidated when material changes cross the assumptions encoded in their validity horizon; rapid technical change is not itself a reason for skepticism, but it is a reason to make the conditions of continued warrant explicit.*

The principle closes the section by locating the AI-era problem within the broader limitation grammar of Chapter 24. Capability asymmetry, epistemic dependence, opacity, delegated judgment, synthetic evidence, accelerated theory production, attention and orientation, and institutional dependence are not arguments that AI-related economic analysis is impossible. They identify where apparently stable economic objects can be versioned, mediated, path-dependent, and rapidly reconfigured. GRE can remain useful in such an environment if it preserves configuration detail, provenance, verification burdens, capability trajectories, domain-specific correction, and explicit revalidation triggers. The next section turns from these moving limitation conditions to a more general empirical question: how GRE can identify generativity, relational causality, value conversion, capture, option-space change, power conversion, historical effects, long-horizon outcomes, and negative evidence in observational and intervention settings.

24.18 Empirical Identification Problems

The preceding sections have identified limits in ontology, epistemic access, representation, relational reconstruction, history, formalization, value analysis, power, justice, praxis, cross-domain transfer, and rapidly changing AI-mediated environments. The role of the present section is to concentrate those limitations at the point where GRE claims meet empirical evidence. Its objective is not to prescribe one privileged causal-inference technique. GRE studies heterogeneous objects that differ in observability, manipulability, temporal depth, institutional embedding, and historical specificity. The relevant discipline is therefore broader: an empirical identification claim should state the target mechanism, the observations that bear on it, the inferential bridge between manifestation and mechanism, serious rival explanations, the conditions under which the claim is expected to hold, and the evidence that would weaken or revise it. The section applies that discipline to generativity, relational causality, value conversion, value capture, option-space change, power conversion, historical effects, long-horizon outcomes, and negative evidence.

Definition 24.436 (Empirical-identification profile). A *GRE empirical-identification profile* records the target claim, empirical anchors, observability conditions, temporal and relational boundaries, proposed mechanism, intermediate implications, serious rival explanations, contrastive or negative evidence, identification assumptions, uncertainty, and the strongest attribution supported by the resulting evidence.

The profile extends the empirical programme introduced in Chapter 22 while turning its identification burden into an explicit limitation architecture. An observed association can be descriptively important even when mechanism identification remains weak. A process trace can strongly support sequence and institutional mediation while leaving a counterfactual unresolved. A quasi-experimental contrast can identify an average consequence of an intervention while leaving the relational mechanism partly opaque. Historical comparison can reveal path dependence while offering few repeated observations. Mixed evidence is therefore often appropriate, but methodological plurality does not mean that all combinations of evidence support the same claim.

Table 24.18 summarizes the principal identification hazards developed in the subsections below. It is not a hierarchy of methods; it identifies the empirical work required before a descriptive pattern can be promoted to the stronger GRE mechanism named in the first column.

Definition 24.437 (Mechanism-discrimination requirement). The *mechanism-discrimination requirement* is the requirement that an empirical GRE claim identify which observations would favor the proposed mechanism over serious alternatives capable of producing materially similar manifestations.

The requirement does not imply that every inquiry must establish a unique mechanism. Some research can legitimately end with an equivalence class of plausible explanations. What should be avoided is a stronger mechanism vocabulary than the evidence discriminates. The empirical limitation is therefore often an attribution ceiling rather than a binary verdict of identification or non-identification.

24.18.1 Generativity

Generativity concerns the production of later capabilities, relations, values, institutional forms, knowledge, or options. Empirical identification is difficult because many manifestations used as evidence of generation are themselves selected outcomes. A successful organization may employ well-trained workers, but the organization may have generated those capabilities, selected people who already possessed them, benefited from complementary institutions, or merely revealed capacities that were previously difficult to observe. A policy followed by later entrepreneurial activity may have generated new possibilities, redistributed existing activity, accelerated a trend already under way, or changed the categories through which activity is recorded.

Definition 24.438 (Generativity-identification profile). A *generativity-identification profile* records the proposed source configuration, generated object or capacity, generative mechanism, enabling and maintenance conditions, temporal sequence, intermediate traces, plausible pre-existing capacities, substitution or displacement, competing sources of generation, failed or unrealized cases, and the evidence used to distinguish generation from selection, revelation, persistence, transfer, or redistribution.

Realized output should therefore not be treated as a sufficient proxy for generativ-

Table 24.18: Selected empirical-identification problems in GRE.

Research object	Typical identification hazard	Required empirical discipline
Generativity	Later success is attributed to an earlier configuration without distinguishing selection, persistence, co-generation, or common causes	Trace the generative mechanism, intermediate capacity formation, alternative pathways, delayed effects, and failures
Relational causality	Association among connected positions is treated as causal effect of a relation	Define the relation and estimand, model interference and endogenous relation formation, and compare serious relational alternatives
Value conversion	Covarying source and target manifestations are described as conversion	Reconstruct source, target, interface, conditions, intermediate changes, and rival mechanisms
Value capture	Concentration or unequal receipt is treated as capture	Identify a value pathway, control or appropriation mechanism, relevant alternative incidence, and affected positions
Option-space change	Realized choices are treated as the feasible set	Reconstruct effective possibilities, constraints, information, access, and credible but unrealized alternatives
Power conversion	Resource or status asymmetry is treated as power	Identify the directional mechanism through which an asymmetry becomes consequential capacity over another position's possibilities
Historical effects	Later outcomes are attributed retrospectively to one prior event or institution	Preserve temporal sequence, contemporaneous alternatives, changing categories, intermediate mechanisms, and path-specific rivals
Long-horizon outcomes	Distant consequences are attributed through an uninterrupted causal story	Track mediation, maintenance, competing inputs, attrition, regime change, and horizon-dependent uncertainty
Negative evidence	Non-observation is treated as evidence of absence	Establish trace generation, detection, coverage, preservation, and the expected manifestation under the target claim

ity. The relevant target can include a capacity that remains unused during the observation period, a relation that becomes available only under later conditions, or an option that matters because it can be exercised even if it is not chosen. At the same time, hypothetical future generation cannot be insulated from evidence merely because it concerns unrealized possibilities. GRE needs observable implications of the proposed generative process: intermediate capability formation, changed access, persistent skill, altered institutional routines, credible later reuse, new relational pathways, or systematic differences when enabling conditions are absent.

Definition 24.439 (Generativity rival set). A *generativity rival set* contains serious mechanisms that can explain a later manifestation without the proposed generative process, including where relevant selection, revelation of prior capacity, common-

cause change, persistence, redistribution, displacement, conversion, measurement change, and generation by another source.

Failure cases are particularly valuable. If the alleged source configuration repeatedly appears without the predicted intermediate capability, or if the later capability appears under comparable conditions without the source, the generativity account requires revision. Such evidence need not refute every role of the source. It can narrow the claim from generation to contribution, enablement, acceleration, or conditional participation.

Proposition 24.440 (Generativity-identification condition). *A GRE generativity claim receives stronger empirical support when the generated object is independently typed, intermediate capacity or relation formation is evidenced where observable, serious selection and common-cause explanations are addressed, condition-sensitive or contrastive cases support the proposed pathway, and failed or delayed cases remain capable of narrowing the attribution.*

24.18.2 Relational Causality

Relational causality is more demanding than showing that outcomes are correlated among connected positions. The relevant relation can be constitutive, enabling, constraining, mediating, informational, contractual, infrastructural, symbolic, or directly causal in a narrower intervention sense. GRE therefore needs to specify what causal claim is being made about the relation and what change would count as a change in the causal object.

Definition 24.441 (Relational causal estimand). *A relational causal estimand specifies the relational feature whose consequence is being investigated, the affected positions, the counterfactual or contrastive change in that feature, the relevant boundary and horizon, interference assumptions, and the outcome or relational transformation whose difference is to be attributed.*

This definition prevents relation labels from functioning as unexplained treatments. “Trust,” “dependence,” “ownership,” “membership,” “proximity,” or “centrality” can each contain several empirically distinct relations. A study that changes communication frequency may not have changed trust. A legal reform can alter formal ownership while practical control remains stable. A platform ranking change can affect exposure without changing the underlying social relation. The intervention or variation must correspond sufficiently to the substantive relation named in the causal claim.

Relational systems also create interference. One position’s treatment can alter another position’s exposure, alternatives, expectations, or relational neighborhood. Relation formation is often endogenous: actors select partners, institutions route interaction, and prior outcomes change later ties. Standard independence assumptions can therefore erase the very structure GRE intends to study.

Definition 24.442 (Relational-causality identification burden). *The relational-causality identification burden requires explicit treatment of relation semantics, endogenous relation formation, interference, boundary dependence, temporal ordering, relevant relational alternatives, and the mechanism through which the specified relation is expected to change the target outcome or configuration.*

Proposition 24.443 (Relational causal restraint). *Network association, relational cen-*

trality, repeated interaction, or positional similarity does not by itself identify a causal effect of the named relation; causal attribution should remain bounded by the relation semantics, exposure structure, interference conditions, and contrastive evidence that the empirical design can support.

24.18.3 Value Conversion

Section 24.11 treated value conversion as a mechanism-identification problem and introduced a conversion-identification dossier, rival set, ladder, and attribution ceiling. The empirical limitation can now be stated in the broader language of this section. Conversion is one case in which an observed before–after relation can conceal several different mechanisms. Source depletion and target gain may reflect conversion, but they may also reflect transfer to another position, common-cause change, target-side generation, reclassification, circulation, measurement substitution, or simultaneous manifestation of a third process.

Definition 24.444 (Conversion evidence nesting). *Conversion evidence nesting* is the requirement that evidence for a value-conversion claim preserve separately the source and target typing, interface exposure, condition architecture, intermediate transformation evidence, source-side change, target realization, and serious rival mechanisms rather than compressing them into one source–target association.

The nesting requirement also limits scalar conversion-rate claims. A stable empirical ratio between source and target indicators can be useful descriptively while remaining semantically weaker than a conversion rate. The latter additionally requires a defensible mapping between the value forms, control of relevant conditions, and evidence that the ratio is generated by the proposed interface rather than by changing composition or measurement.

Proposition 24.445 (Conversion identification portability limit). *Empirical support for a conversion mechanism in one institutional regime does not by itself identify the same mechanism, interface, or conversion rate in another regime where source meaning, target realization, eligibility, power, complementary conditions, or measurement architecture differ materially.*

24.18.4 Value Capture

Capture is empirically difficult because several visible patterns can resemble it. Concentrated receipt, high intermediary retention, unequal bargaining outcomes, platform fees, rent, organizational surplus, or persistent advantage can each be normatively or economically important without establishing capture in the specific GRE sense. Capture requires a pathway through which value, value-bearing conditions, or generative returns that could have remained available to other positions are redirected, retained, appropriated, or made conditionally accessible through a consequential mechanism.

Definition 24.446 (Capture-identification dossier). A *capture-identification dossier* records the value form or return at issue, the circulation or conversion pathway, claimant and affected positions, the proposed capture point, the control or appropriation mechanism, the relevant alternative incidence, contractual or institutional rules, contribution and risk where material, persistence, and the evidence distinguishing capture from legitimate payment, transfer, concentration, or ordinary

intermediation.

The relevant alternative is especially important. Without a plausible account of what would have occurred absent the alleged capture mechanism, the concept can become a label for any unequal distribution. Yet the alternative need not be an idealized equal distribution. It can be a historically available contractual arrangement, a feasible routing architecture, an institutional benchmark, a before–after comparison, or a comparative case that changes the capture mechanism while preserving other relevant conditions.

Definition 24.447 (Capture counterfactual range). A *capture counterfactual range* is the set of empirically serious alternative incidences of the relevant value or return under feasible changes to the alleged capture mechanism, with uncertainty about contribution, bargaining, risk, substitution, and third-party effects kept explicit.

Proposition 24.448 (Capture-identification condition). *Unequal receipt or retention supports a GRE capture claim only when evidence additionally identifies a materially consequential routing, appropriation, recognition, conversion, or control mechanism and supports a relevant alternative incidence against which the alleged capture is interpreted.*

24.18.5 Option-Space Change

Option-space change is among the most difficult GRE objects to identify because possibilities are not identical to observed choices. A person may not exercise a feasible option because it is unattractive, costly, unfamiliar, risky, normatively rejected, or unnecessary. Conversely, an observed action can occur under severe constraint and therefore reveal little about the breadth of available alternatives. Realized behavior is evidence about an option space only through an additional model of access, feasibility, knowledge, timing, and constraint.

Definition 24.449 (Effective option-space identification profile). An *effective option-space identification profile* records the focal position, candidate possibilities, material and institutional access conditions, information and recognition conditions, timing, costs, rights, relational dependencies, relevant thresholds, credible but unrealized alternatives, observed exercises or foreclosures, and uncertainty concerning possibilities that remain latent or unobserved.

Direct enumeration is sometimes possible. Eligibility rules can define an administrative set; transport infrastructure can determine reachable locations under specified time and cost constraints; technical permissions can define accessible operations. In other settings the space is partly latent. Career possibilities, political voice, social mobility, entrepreneurial opportunity, or capability under institutional change can require mixed evidence from histories, interviews, records, experiments, comparative cases, and structural constraints.

Definition 24.450 (Option-realization fallacy). The *option-realization fallacy* is the inference that the set of observed actions adequately represents the set of effectively available possibilities without independent evidence concerning access, knowledge, feasibility, constraint, and credible non-use.

Proposition 24.451 (Option-space change condition). *A GRE claim that an intervention or historical process expands or contracts an option space is strengthened when the relevant possibilities are defined independently of realized choice, the constraints*

and access conditions governing them are reconstructed, changes in credible unrealized alternatives are evidenced where possible, and substitution among options is distinguished from genuine creation or foreclosure.

24.18.6 Power Conversion

Chapter 16 treated power as a relational conversion problem: an asymmetry becomes power-relevant when a specified mechanism makes it consequential for another position's feasible action or future possibilities. Section 24.13 later showed why persistent asymmetry, capacity, control, and power should remain distinct. Empirical identification must therefore locate the conversion pathway between a difference in resources, information, timing, status, infrastructure, recognition, exit, or institutional position and a realized or credible capacity to condition others.

Definition 24.452 (Asymmetry-to-power conversion profile). An *asymmetry-to-power conversion profile* records the initial asymmetry, the positions involved, the conversion mechanism, dependence or bottleneck conditions, practical alternatives, credible activation or withholding capacity, observed exercise or anticipatory response, counter-power, temporal persistence, and the evidence that distinguishes power conversion from correlation between advantage and outcome.

Observed exercise is useful but not necessary. A credible ability to exclude, delay, withdraw, classify, reroute, or change terms can influence behavior without repeated overt intervention. Yet latent capacity should not become empirically unrestricted. Evidence can include contractual rights combined with practical enforceability, documented dependence, bottleneck structure, observed anticipatory adaptation, rule-setting authority, historical episodes of activation, or changes in behavior when the conversion pathway is weakened.

Definition 24.453 (Power-conversion rival set). A *power-conversion rival set* contains serious explanations for an outcome associated with an asymmetry that do not require the proposed power mechanism, including productivity differences, voluntary specialization, shared constraint, institutional rule application without discretionary control, third-party enforcement, selection, and correlated advantage generated elsewhere.

Proposition 24.454 (Power-conversion identification condition). A *resource, status, informational, temporal, or infrastructural asymmetry should be described as converted into economic power only when evidence identifies a directional mechanism through which the asymmetry materially conditions another position's possibilities and serious non-power explanations of the observed outcome are correspondingly limited.*

24.18.7 Historical Effects

Historical-effect identification is constrained by the conditions developed in Section 24.6. Archives are selective, categories change, temporal processes operate at different speeds, and later knowledge can make a realized path look more necessary than it appeared to contemporaries. A historical GRE claim must therefore reconstruct both the observed sequence and the contemporaneous possibility structure rather than infer causality backward from the outcome.

Definition 24.455 (Historical-effect identification dossier). A *historical-effect identification dossier* records the focal event, relation, institution, or configuration; the hy-

pothesized effect; contemporaneous conditions and alternatives; temporal ordering; intermediate transformations; archival and category limitations; competing historical mechanisms; comparative or within-case contrasts; later reinterpretations; and the findings that would narrow the attribution.

Historical evidence can identify mechanisms strongly without experimental manipulation. Process tracing, institutional sequences, archival discontinuities, comparative histories, legal changes, natural experiments, actor records, material traces, and temporal coincidence with theoretically predicted intermediate changes can jointly constrain an account. The limitation lies not in the absence of random assignment as such, but in whether the historical reconstruction discriminates among serious mechanisms with enough precision for the claim being made.

Definition 24.456 (Retrospective causal compression). *Retrospective causal compression* occurs when a later outcome is explained by a small set of antecedents while intermediate contingencies, failed alternatives, category changes, maintenance conditions, and interacting mechanisms are removed from the causal narrative.

Proposition 24.457 (Historical attribution restraint). *The explanatory prominence of an antecedent in a retrospective narrative should not exceed the evidence that its mechanism remained consequential through the intervening sequence; where later maintenance, adaptation, substitution, or contingency materially shaped the outcome, historical attribution should preserve those mediations rather than treating temporal priority as sufficient causality.*

24.18.8 Long-Horizon Outcomes

Long-horizon identification compounds the preceding problems. The further an outcome lies from a proposed source, the more opportunities arise for maintenance, decay, substitution, adaptation, feedback, institutional change, new technologies, changing value forms, and exogenous shocks. A distant association can therefore be real and still provide weak evidence about the original mechanism.

Definition 24.458 (Long-horizon attribution chain). *A long-horizon attribution chain* records the proposed source, intermediate states and mechanisms, maintenance or regeneration conditions, competing inputs, feedback, attrition, regime changes, measurement changes, terminal outcome, and uncertainty accumulated across the temporal sequence.

This chain need not require every intermediate state to be observed directly. Some segments can be supported through structural constraints, historical records, repeated local mechanisms, or convergent evidence. The discipline is to distinguish observed links, strongly inferred links, weakly inferred links, and genuinely open segments. A long-horizon conclusion can remain useful when it identifies a persistent contribution or risk pathway rather than claiming deterministic control of the terminal outcome.

Definition 24.459 (Attribution decay profile). *An attribution decay profile* records how uncertainty concerning a source's contribution changes across time as mediation, competing causes, adaptation, measurement change, and regime instability accumulate, together with observations that can renew or strengthen the attribution at intermediate stages.

The concept does not impose a universal mathematical decay rate. Some mech-

anisms strengthen through positive feedback; others remain stable because institutions reproduce them; still others disappear rapidly. The point is that evidential confidence should not remain automatically constant merely because the narrative maintains verbal continuity.

Proposition 24.460 (Long-horizon identification condition). *A strong GRE long-horizon attribution requires more than temporal precedence and endpoint association: it should preserve material intermediate mechanisms, maintenance or regeneration conditions, competing causes, regime changes, and uncertainty, with the strength of the terminal claim bounded by the weakest consequentially relevant parts of the attribution chain.*

24.18.9 Negative Evidence

Negative evidence is indispensable because the framework is intended to remain corrigible. Yet non-observation is not automatically evidence of absence. A relation can fail to appear because no trace was generated, the trace was not recorded, the dataset excludes the relevant positions, the observation window is too short, categories suppress the distinction, records were destroyed, or the manifestation relation changed. Conversely, a theory that treats every missing expected effect as an observability problem becomes empirically insulated.

Definition 24.461 (Negative-evidence observability condition). *A negative-evidence observability condition specifies whether the target mechanism, if present at the claimed strength and under the stated conditions, would be expected to generate a detectable and preserved manifestation within the available observation regime.*

This condition makes absence informative in proportion to expected detectability. If a proposed conversion mechanism predicts a documented intermediate administrative action and comprehensive records show none, the absence can weigh strongly against the mechanism. If an informal relation is rarely recorded and the archive contains only formal documents, non-observation carries little weight. The same logic applies to generativity, capture, power, option creation, and long-horizon effects.

Definition 24.462 (Negative-evidence diagnostic profile). *A negative-evidence diagnostic profile records the predicted manifestation, trace-generation process, detection probability or qualitative detectability, coverage, preservation, observation horizon, data-quality limitations, null or contrary finding, implementation quality, and the claim component that the negative evidence can legitimately weaken.*

Negative evidence should also be distinguished from evidence of an alternative mechanism. A null estimate can show that one expected average effect is not detectable under a design without establishing why. A failed generative intervention can reflect an incorrect mechanism, absent enabling conditions, implementation failure, insufficient horizon, or measurement weakness. Diagnostics should identify which layer is implicated rather than moving directly from non-success to total theoretical rejection.

Definition 24.463 (Identification status ladder). *An identification status ladder distinguishes, for a specified GRE claim, descriptive pattern, mechanism-compatible evidence, process-supported attribution, contrastively supported mechanism, regime-bounded identification, and broader transportable identification, with each stronger status requiring additional evidential and scope conditions rather than merely more observations of the same type.*

The ladder is deliberately non-numeric. Different research objects admit different designs, and some historically important mechanisms cannot be repeatedly manipulated. Its function is to make claim strength explicit and cumulative. A project can advance by moving one mechanism from compatibility to process support, by discovering a scope boundary that turns a broad claim into a regime-bounded one, or by producing high-quality negative evidence that removes one rival explanation.

Proposition 24.464 (Empirical identification limitation principle). *GRE should treat empirical identification as a claim-relative and mechanism-discriminating process: evidence should support no stronger attribution than its observability, temporal reconstruction, relation semantics, rival-mechanism discrimination, negative evidence, and scope conditions permit, and persistent identification failure should narrow, retype, or withdraw the dependent claim rather than be absorbed into increasingly permissive relational language.*

This principle identifies both the empirical ambition and the empirical limit of GRE. The framework is useful only if its distinctive objects—generativity, conversion, capture, changing option spaces, relational power, historical trajectories, and long-horizon effects—can be connected to evidence in ways that distinguish at least some serious alternatives. It need not reduce every object to one experiment, coefficient, or dataset. It does require a research architecture in which stronger mechanism language incurs stronger identification burdens and in which negative findings can alter the theory. The next section turns to a different limitation. Even where empirical mechanisms are well identified, evidence may remain insufficient to determine one uniquely warranted normative judgment.

24.19 Normative Underdetermination

Section 24.18 established that GRE mechanism language should be no stronger than the evidence that discriminates the proposed mechanism from serious rivals. The role of the present section is to examine a different limitation that remains even after descriptive and causal identification is comparatively strong. Its objective is to specify how several serious normative evaluations can remain compatible with the same well-reconstructed economic configuration, to identify the premises at which those evaluations diverge, and to state what GRE can and cannot conclude without importing a complete moral, legal, or political theory. The method is premise-tracing rather than normative aggregation. Empirical findings constrain the admissible description of consequences, affected positions, capacities, burdens, power, option structures, and historical transmission; normative conclusions additionally depend on judgments concerning standing, baseline, rights, priority, threshold, responsibility, aggregation, procedure, and temporal concern. Normative underdetermination therefore concerns the residual plurality of warranted evaluation after relevant empirical uncertainty has been reduced, not the absence of reasons or the impossibility of judgment.

Definition 24.465 (GRE normative-evaluation profile). *A GRE normative-evaluation profile records the empirical object and evidential status, affected positions and standing assumptions, relevant value forms and burdens, proposed normative framework or premises, baseline, priority or aggregation rule where applicable, rights or constraints, temporal horizon, domain-specific normative authority, re-*

sulting conditional judgment, serious rival judgments, and unresolved normative remainder.

The profile generalizes the justice-specific analysis of Section 24.14. It prevents a technically rich description from silently carrying an unmarked evaluative conclusion. The same empirically identified configuration can be evaluated differently because one framework prioritizes rights, another gives greater weight to aggregate consequences, another emphasizes relational non-domination, another protects sufficiency thresholds, and another assigns special weight to historical repair or future generations. These disagreements can sometimes be narrowed by better facts, but they cannot always be eliminated by more detailed measurement of the same facts.

Definition 24.466 (Fact–norm bridge). A *fact–norm bridge* is an explicit premise or rule connecting a descriptive or causal GRE finding to a normative judgment, priority, permission, prohibition, obligation, or evaluative ranking.

Table 24.19 summarizes recurrent cases in which descriptive clarity does not itself settle evaluative authority. The table is not a catalogue of normative theories. It identifies the additional bridge that must be made visible before a GRE property is treated as a reason for action or institutional judgment.

24.19.1 Empirical Constraint on Normative Judgment

Facts do not mechanically generate normative conclusions, but normative arguments are not independent of facts. A recommendation can rely on a mistaken account of who bears a burden, whether a capability is actually accessible, whether a conversion interface is voluntary, whether an intervention preserves options, or whether a historical claim is causally connected to a present configuration. Empirical correction can therefore defeat a normative argument by undermining one of its factual premises even where the underlying normative principle remains unchanged.

Definition 24.467 (Empirical–normative chain). An *empirical–normative dependency chain* records the descriptive and causal findings used in a normative argument, the fact–norm bridges applied to them, the intermediate evaluative conclusions, the final judgment or recommendation, and the points at which revised evidence would change the argument.

This chain helps distinguish disagreement about evidence from disagreement about normative premises. Two researchers can share a normative commitment while disagreeing about whether the empirical conditions activating it are present. Conversely, they can agree fully on the economic reconstruction and still disagree because they assign different standing, thresholds, baselines, rights, or priorities. These are different intellectual situations and should not be collapsed into one generic category of value disagreement.

Definition 24.468 (Normative-premise sensitivity profile). A *normative-premise sensitivity profile* identifies which normative premises are necessary for a GRE-supported judgment, which conclusions remain stable across serious alternative premises, which conclusions reverse or become indeterminate, and which empirical findings would materially change the sensitivity pattern.

Empirical enrichment can narrow underdetermination. If several normative frameworks reject domination, then stronger evidence of coercive dependency can create convergence even where the frameworks disagree elsewhere. If an alleged

Table 24.19: Selected sources of normative underdetermination in GRE.

GRE finding	Normative ambiguity	Required evaluative discipline
Generativity	More generated capacities or possibilities can include harmful, exclusionary, or dominating consequences	Specify what is generated, for whom, with which burdens, and under which value rule
Stability	Persistence can protect valuable coordination or reproduce oppression and lock-in	Identify the object preserved, alternatives suppressed, transition costs, and normative basis for preservation
Capability	Expanded practical ability can improve agency while remaining unjustly distributed or increasing capacity to dominate	Separate capability magnitude from standing, distribution, burden, rights, and relational position
Option expansion	A larger option set can increase freedom or impose maintenance costs, harmful choices, manipulation, or decision burden	Evaluate effective accessibility, quality, distribution, reversibility, and foreclosed commitments
Efficiency or conversion success	Efficient transformation can coexist with capture, coercion, unequal standing, or residual loss	State the protected values, incidence, interface control, and non-converted remainder
Power reduction	Reduced conditioning capacity in one relation can increase vulnerability or transfer power elsewhere	Trace the affected relations, safeguards, alternatives, and normative object of the intervention
Institutional settlement	A rule, vote, market, court, or administrative process can produce practical determinacy without resolving value conflict	Distinguish procedural authorization from substantive normative resolution
Cross-domain consequence	Economic effects can be normatively relevant without establishing legal validity, political legitimacy, educational quality, ecological worth, or other domain judgments	Preserve domain-specific normative provenance and correction authority

benefit disappears under better identification, frameworks that previously disagreed over distribution of that benefit may converge in rejecting the policy. Such convergence is analytically important, but it does not prove that one framework is universally correct.

Proposition 24.469 (Factual-refinement condition). *Better empirical identification can eliminate normative conclusions that depend on false or unsupported factual premises and can create cross-framework convergence, but it does not by itself select among serious normative frameworks whose remaining disagreement arises from distinct standing, priority, rights, baseline, aggregation, procedural, or temporal premises.*

Normative underdetermination is therefore compatible with rigorous empirical criticism. It is not a license to treat every normative position as equally supported. Some positions can be factually inconsistent, internally incoherent, incompatible with their own declared premises, or dependent on consequences that the evidence does not support. The limit concerns what remains after those defects have been addressed.

24.19.2 Normative Status of Generativity

Generativity is one of GRE's most distinctive descriptive objects, but it is not an independent source of moral authority. Section 24.9 distinguished generative attribution from generative value. The present subsection states the broader normative implication. A process can generate capabilities, institutions, knowledge, relations, identities, options, or future conversion pathways while also generating domination, ecological burden, exclusion, dependency, fragility, or destructive capacity. Conversely, restraint, preservation, refusal, or closure can be normatively justified where further generation would damage protected values or relations.

Definition 24.470 (Generativity–goodness bridge profile). A *generativity–goodness bridge profile* records the generated or preserved objects, affected positions, positive and negative downstream consequences, foreclosed alternatives, distribution of generative capacity, relevant protected values, normative premise connecting generation to evaluation, and the horizon over which the judgment is made.

The profile prevents a common teleological slide. A historically generative institution is not therefore good because it produced many later developments, and an institution that slows transformation is not therefore bad because it reduces novelty. Historical influence and normative merit are different claims. The same distinction applies to innovation policy, education, research, infrastructure, artificial intelligence, finance, and organizational design.

Definition 24.471 (Generative-direction remainder). A *generative-direction remainder* consists of normatively relevant consequences concerning the kind, distribution, accessibility, reversibility, burden, or foreclosure of generation that are not represented by a claim that a system is more or less generative.

Generativity can nevertheless be normatively relevant. A framework that values agency can treat capability generation as one reason in favor of a configuration; a framework concerned with future generations can value preservation of regenerative capacity; a framework concerned with domination can object to generativity concentrated in one position's ability to shape others. The same generative fact can therefore enter different normative arguments without possessing one built-in evaluative sign.

Proposition 24.472 (Generativity normative non-sufficiency). *Evidence that a configuration is more generative does not by itself establish that it is normatively superior; the evaluative conclusion depends on what is generated or foreclosed, for whom, through which relations, with which burdens and power effects, under which temporal horizon, and according to which independently stated normative premises.*

24.19.3 Normative Status of Stability

Stability has a similar ambiguity. Persistent institutions can support trust, coordination, identity, long-horizon investment, care, rights protection, ecological stewardship, or predictable conversion rules. The same persistence can reproduce domination, exclusion, obsolete categories, locked-in infrastructure, unequal property relations, or harmful dependency. Instability can destroy valuable relations, yet destabilization can also be necessary for reform.

Definition 24.473 (Stability-evaluation profile). A *stability-evaluation profile* records the object and mechanism of persistence, beneficiaries and burdened positions, protected functions, reproduced harms, adaptation capacity, exit and revision conditions, suppressed alternatives, transition costs, and the normative premise under which preservation or destabilization is evaluated.

This profile applies equally to resilience. A system can be resilient because it regenerates valuable coordination after disturbance, or because power holders possess sufficient resources to reproduce an unjust arrangement. Resilience is therefore relationally and normatively typed. The same is true of equilibrium, near-criticality, robustness, and institutional continuity. None receives a positive normative sign merely from dynamical persistence.

Definition 24.474 (Preservation–change tension). A *preservation–transformation tension* exists when preserving a valued relation, institution, capability, or coordination structure materially conflicts with changing another normatively salient burden, exclusion, relation, or power structure.

Such tensions can be genuine rather than artifacts of poor modeling. A welfare institution can require continuity while its eligibility categories require reform. A community can value relational continuity while younger members seek broader options. An ecological regime can require long-horizon stability while livelihoods need near-term transformation. GRE can reconstruct these couplings and transition burdens; the relative normative priority among them requires additional premises.

Proposition 24.475 (Stability normative non-sufficiency). *Persistence, resilience, robustness, equilibrium, or successful reproduction of a relational configuration does not by itself establish its goodness, legitimacy, or justice; normative evaluation requires specification of what is being preserved, which alternatives are constrained, who bears the costs of continuity or change, and why preservation has evaluative priority in the stated context.*

24.19.4 Capacity Expansion in Justice Evaluation

Capability and capacity language can appear normatively attractive because expanded practical ability often supports agency, participation, learning, resilience, or future possibility. Yet an increase in capacity is not equivalent to an increase in justice. Capacity can be distributed unequally, generated through exploitation, exercised to dominate others, or accompanied by burdens that fall on positions whose own capacity contracts. Some capacities can also be normatively restricted because their exercise violates rights or threatens protected ecological, relational, or institutional conditions.

Definition 24.476 (Capacity-justice bridge). A *capacity-justice bridge* specifies which capacity is normatively relevant, whose capacity counts and with what standing, how

the capacity was generated, its effective accessibility and durability, burdens and externalities, distribution across positions, interaction with rights and dependence, and the normative principle connecting capacity to a justice judgment.

The distinction is important for economic development, education, AI access, health, financial inclusion, public infrastructure, and organizational capability. A programme can increase average capability while deepening dependence on an infrastructure controlled by a narrow set of actors. Another can distribute resources equally while producing unequal capability because positions face different conversion conditions. GRE can identify these mechanisms without treating one empirical capability measure as a complete justice criterion.

Definition 24.477 (Capacity asymmetry remainder). A *capacity asymmetry remainder* consists of normatively relevant differences in standing, burden, dependence, control, rights, vulnerability, historical position, or conversion conditions that remain after the magnitude of the focal capacities has been compared.

Capacity also interacts with responsibility. Greater capacity can create stronger expectations of contribution under some normative frameworks, while other frameworks resist deriving obligations merely from ability. GRE can show who can act, who controls enabling resources, and who is positioned to repair harm. The transition from ability to duty is a separate normative bridge.

Proposition 24.478 (Capacity non-derivation condition). *An observed increase, equality, or asymmetry of capacity does not uniquely determine justice, entitlement, responsibility, or obligation; such conclusions require independent premises concerning standing, rights, burden, historical responsibility, conversion conditions, and the legitimate relation between ability and duty.*

24.19.5 Normative Evaluation of Option Expansion

GRE repeatedly treats option spaces as economically important because institutions, resources, relations, knowledge, and power can expand or contract what positions can credibly do. Option expansion is nevertheless normatively ambiguous. A larger formal choice set can contain inaccessible options, harmful options, manipulative choices, high-maintenance options, or possibilities that impose decision burdens. Valuable commitments can also reduce some future options deliberately: contracts, caregiving relationships, constitutional rules, professional obligations, ecological protection, and long-term public investment can each close possibilities in order to preserve other goods.

Definition 24.479 (Option-expansion value profile). An *option-expansion value profile* records the options added or removed, effective accessibility, quality and consequence of the options, distribution across positions, information requirements, maintenance cost, decision burden, manipulation or coercion risk, reversibility, protected commitments, and the normative premise connecting optionality to value.

The profile separates formal multiplicity from effective freedom. Ten nominal options can provide less practical agency than three credible options if the former are inaccessible, poorly understood, strategically structured, or dependent on relations outside the chooser's control. Conversely, a temporarily inaccessible option can remain valuable where preserving it protects future autonomy under improved information.

Definition 24.480 (Option-quality remainder). An *option-quality remainder* comprises normatively relevant properties of an option set that are not captured by its cardinality or nominal expansion, including accessibility, safety, information, reversibility, dignity, dependency, maintenance burden, and effects on other positions.

Option contraction can therefore be either harmful foreclosure or justified constraint. Regulation can remove exploitative options; environmental protection can close profitable but destructive uses; professional standards can remove unsafe practices; an individual commitment can voluntarily narrow later choice. GRE can reconstruct who closes which options, through what authority, and with which consequences. Whether the closure is justified depends on the accompanying normative argument.

Proposition 24.481 (Optionality normative non-monotonicity). *Normative value need not increase monotonically with the number of available options; the evaluative significance of option expansion depends on effective accessibility, option quality, distribution, burdens, effects on others, protected commitments, and the normative reasons for preserving or constraining the relevant possibility space.*

24.19.6 Plural Normative Framework Comparison

Normative underdetermination becomes clearest when several serious frameworks are applied to the same empirically reconstructed configuration. A rights-oriented analysis can object to an intervention that produces large aggregate gains by violating protected claims. A prioritarian or sufficientarian analysis can evaluate the same distribution differently from an equalizing rule. A relational analysis can focus on domination or dependence that an outcome metric omits. A historical-repair framework can assign weight to past wrongs that a forward-looking framework treats differently. These examples do not imply that all frameworks are equally coherent or appropriate. They show that empirical completeness does not eliminate the need to state which normative architecture is doing the evaluative work.

Definition 24.482 (Normative-framework comparison dossier). A *normative-framework comparison dossier* records the common empirical reconstruction, each serious framework's standing rules, baselines, protected claims, thresholds, priorities, aggregation or non-aggregation rules, temporal treatment, procedural authority, conditional judgment, and the loci at which conclusions converge or diverge.

Comparison can improve normative analysis even when it does not yield a single ranking. Some conclusions can be robust across frameworks. A policy can remain objectionable because it fails its stated objective, imposes severe uncompensated burdens, or creates concentrated domination under several different evaluative architectures. Other conclusions can remain framework-sensitive. The appropriate output can therefore be a conditional map rather than a forced meta-ranking.

Definition 24.483 (Cross-framework convergence set). A *cross-framework convergence set* contains the judgments, constraints, or priorities supported by several serious normative frameworks despite differences in their deeper premises, together with the empirical conditions on which that convergence depends.

Definition 24.484 (Cross-framework divergence set). A *cross-framework divergence set* contains materially different judgments that remain after the frameworks have been applied to the same relevant empirical reconstruction, with the responsible normative divergence loci identified explicitly.

Neither set establishes ultimate normative truth. Convergence can arise from shared but contestable premises; divergence can reflect genuine pluralism or unresolved argument rather than permanent incomparability. The analytical gain lies in locating the disagreement instead of allowing it to hide inside technical choices such as discount rates, welfare weights, thresholds, eligibility rules, or optimization objectives.

Proposition 24.485 (Conditional normative determinacy). *GRE can support determinate normative conclusions conditional on explicit normative premises and can identify conclusions robust across several serious frameworks, but cross-framework convergence should not be treated as proof of universal validity and persistent divergence should not be concealed by an unmarked aggregate objective.*

24.19.7 Domain-Specific Normative Authority

Normative premises are also domain-sensitive. Economic consequences can matter greatly to legal, political, educational, ecological, medical, technological, or aesthetic judgments without exhausting the normative objects of those domains. A policy that increases economic capability does not thereby become legally valid. A technically effective AI deployment does not thereby become institutionally legitimate. A profitable ecological intervention does not establish ecological acceptability. A learning technology that raises measured productivity does not establish educational quality. The domain-transfer discipline of Section 24.16 therefore applies to normative authority as well as descriptive concepts.

Definition 24.486 (Domain-normative provenance profile). A *domain-normative provenance profile* records the normative claim, the domain whose objects and standards it concerns, the economic findings GRE contributes, the external normative premises or authorities required, translation or conflict across domains, the correction source, and the GRE conclusions that would change if the domain-specific normative judgment were revised.

The profile does not require disciplinary isolation. Economic analysis can reveal hidden burdens that materially alter a legal or political judgment; ecological analysis can change what an economic intervention counts as feasible; educational theory can revise the meaning of capability generation; political theory can challenge whether a procedurally efficient arrangement is legitimate. The point is reciprocal correction without silent annexation.

Definition 24.487 (Normative-authority transfer limit). A *normative-authority transfer limit* is reached when a GRE property or economic criterion is used to settle a domain-specific normative judgment whose validity depends on standards, standing relations, or justificatory premises not established by the economic analysis itself.

Domain-specific normativity can also feed back into GRE. If law determines that a nominally transferable entitlement is non-transferable, if ecology establishes a protected threshold, or if educational theory rejects a performance proxy as an adequate educational objective, the economic analysis should update its feasible set, conversion architecture, value representation, or scope. Such correction does not subordinate economics generally to another domain; it recognizes claim-specific provenance.

Proposition 24.488 (Domain-specific normative deference). *Where a GRE conclusion depends materially on a legal, political, ecological, educational, technological, or other domain-specific normative judgment, GRE should preserve the external provenance and*

revisability of that judgment rather than treating economic consequence, efficiency, generativity, or practical settlement as independent normative authority over the receiving domain.

24.19.8 Scope of GRE Normative Claims

Normative underdetermination does not require GRE to be normatively silent. Economic analysis can reveal hidden incidence, dependency, interface control, generated or foreclosed possibilities, and delayed or residual burdens; such findings can defeat normative arguments that rely on inaccurate descriptions. GRE can also reason conditionally from explicit principles and identify judgments robust across several serious frameworks.

Definition 24.489 (GRE normative-claim ladder). The *GRE normative-claim ladder* distinguishes: normatively relevant empirical description; framework-relative conditional evaluation; cross-framework convergence; explicitly justified substantive normative commitment; and current normative non-claim. Movement to a stronger level requires additional normative warrant rather than additional economic detail alone.

The fourth level is possible only through additional argument. A research programme can explicitly defend a right, threshold, standing rule, democratic principle, ecological constraint, or other commitment and then examine its economic realization. The commitment should not be presented as if it followed analytically from relation, generation, efficiency, stability, capacity, or option structure itself.

Definition 24.490 (GRE normative-claim ceiling). A *GRE normative-claim ceiling* is the strongest normative conclusion supported by the combination of empirically warranted economic findings, explicitly stated normative premises, domain-specific authority, cross-framework robustness where relevant, and acknowledged unresolved remainder in a scoped inquiry.

This ceiling remains compatible with practical responsibility. Institutions may need to act while disagreement persists. The participatory, reversible, monitored, repairable, and reopenable architecture of Section 24.15 can support conditional settlement without redescribing it as final normative resolution.

Definition 24.491 (Normative openness without neutrality). *Normative openness without neutrality* is the stance in which GRE rejects self-validating moral interpretations of its descriptive properties while permitting factual criticism, conditional evaluation, cross-framework comparison, disclosure of power and burden, and independently justified substantive commitments.

The stance avoids normative overreach, where technical vocabulary hides a contestable priority, and false neutrality, where existing institutions, metrics, market outcomes, or administrative settlements are treated as normatively unproblematic because no premise is stated. Silence can itself preserve an inherited normative architecture.

Proposition 24.492 (Normative-underdetermination principle). *Even when a GRE empirical structure is strongly identified, no uniquely authoritative normative ordering should be claimed beyond explicit premises, domain-specific standards, and defensible fact–norm bridges; unresolved divergence should not be converted into apparent determinacy by generativity, stability, capability, optionality, efficiency, or aggregation alone.*

Normative underdetermination is therefore a boundary on derivation, not on inquiry. GRE can expose consequences, dependencies, conversion, capture, circulation, power, option structure, historical transmission, and residual value; it can also distinguish empirical disagreement from persistent normative divergence and identify conditional or cross-framework conclusions. It cannot, without additional argument, convert those descriptive resources into a complete moral ordering. The next section turns to the recurrent failure modes through which GRE could exceed its relational, generative, formal, historical, normative, methodological, disciplinary, or conceptual warrant.

24.20 Failure Modes of GRE

The preceding sections have identified ontological, epistemic, representational, relational, historical, formal, value-theoretical, power-theoretical, normative, practical, cross-domain, AI-era, and empirical-identification limits. The role of the present section is to convert that dispersed limitation architecture into a diagnostic taxonomy of characteristic ways in which Generative Relational Economics can exceed its own warrant. A failure mode is not yet identical to evidence that GRE is false. It is a recurrent pattern of reasoning, modelling, interpretation, or transfer through which a GRE analysis can become weaker than its vocabulary suggests. The objective is therefore operational: to distinguish local misuse from recurrent programme-level weakness, identify observable symptoms, specify proportionate corrections, and state when repeated local repair should instead escalate into the stronger question developed in the next section: what would count against GRE itself.

Definition 24.493 (GRE failure-mode profile). A *GRE failure-mode profile* records the analytical move at risk, the claim whose warrant is exceeded, the evidence or bridge that is missing, observable symptoms of the failure, serious rival interpretations, the smallest adequate correction, the expected domain of recurrence, and the conditions under which repeated recurrence should trigger revision of the framework rather than only correction of one application.

Failure modes matter because a flexible relational vocabulary can absorb anomalies too easily if every difficulty is redescribed as another relation, another layer of generativity, another hidden field, another manifestation problem, or another domain-specific exception. Such flexibility can be productive when it preserves genuinely distinct mechanisms. It becomes a liability when it protects the framework from discrimination. The diagnostic task is therefore not to make GRE inflexible, but to ensure that flexibility remains answerable to differences in mechanism, evidence, semantics, history, and normative authority.

Table 24.20 summarizes the eight failure families developed below. They can co-exist within one analysis. A historical account can simultaneously exhibit relational, generative, formal, and normative overreach; a cross-domain AI study can combine domain overreach with conceptual inflation and methodological mismatch. The taxonomy is therefore diagnostic rather than mutually exclusive.

Definition 24.494 (Failure-mode severity profile). A *failure-mode severity profile* distinguishes at least three levels: a local application defect that can be corrected without changing the relevant GRE concept; a recurrent programme-level weakness indicating that the concept, method, or bridge is systematically underspecified; and a

Table 24.20: Characteristic failure modes of GRE and their primary corrective discipline.

Failure mode	Characteristic symptom	Primary corrective discipline
Relational overreach	An observed context, association, dependence, or co-occurrence is relabeled as a relation without specifying type, direction, persistence, mechanism, or explanatory gain	Define the relation and its rivals; test boundary and scale sensitivity; preserve non-relational explanatory remainder
Generativity overreach	Persistence, transfer, selection, revelation, conversion, or later success is described as generation	Type the generated object, trace the generative mechanism, and compare rival processes and failure cases
Formal overreach	Mathematical precision, elegance, or structural resemblance exceeds the warranted semantics, identification, or empirical correspondence	State the formal role, bridge assumptions, closure, parameter status, and evidential ceiling; simplify when added structure does not discriminate
Historical overreach	Present categories, realized outcomes, or one salient antecedent are projected backward or transported across periods without adequate historical reconstruction	Reconstruct contemporaneous categories, alternatives, timescales, mediation, archival limits, and transportability conditions
Normative overreach	Generativity, stability, efficiency, capability, optionality, participation, or settlement is treated as self-validating normative authority	State the independent normative premise, standing rule, baseline, threshold, domain authority, and unresolved divergence
Methodological overreach	A preferred method determines the question, evidential standard, or admissible object rather than being selected for the local inferential task	Match method to object and claim; preserve triangulation, rival methods, and explicit method-specific blind spots
Domain overreach	GRE vocabulary or economic consequence is used to settle legal, political, ecological, educational, technological, historical, or aesthetic claims outside economic warrant	Preserve translation loss, receiving-domain semantics, external warrant, and claim-specific correction authority
Conceptual inflation	Core terms expand until nearly every phenomenon can be described as relation, value, power, field, generativity, spacetime, conversion, or circulation	Re-establish exclusion conditions, distinguish neighboring concepts, and narrow, retype, decompose, or retire concepts that lose discrimination

framework-level challenge in which the recurrent failure persists despite explicit correction and therefore bears on the adequacy of the GRE architecture itself.

The distinction prevents two opposite mistakes. One is to interpret every poor application as evidence against GRE. The other is to classify every counterexample as user error. Repeated inability to apply a concept without semantic stretching is itself evidence about the concept. Repeated need for unobserved mechanisms or ad hoc domain exceptions is likewise relevant to the research programme, even if no single case is decisive.

24.20.1 Relational Overreach

Relational overreach occurs when the fact that economic phenomena are embedded in relations is allowed to substitute for a discriminating relational explanation. Nearly any social, institutional, material, ecological, or technical phenomenon can be described as relational at a sufficiently general level. The analytical question is not whether relations exist, but whether a specified relation contributes explanatory discrimination beyond a looser description of context, correlation, co-membership, or mutual influence.

Definition 24.495 (Relational explanatory substitution). *Relational explanatory substitution* occurs when naming a phenomenon as relational replaces, rather than advances, the specification of the relevant relation type, direction, mechanism, persistence, boundary, scale, and consequences.

A common symptom is semantic upgrading. Repeated interaction becomes trust; centrality becomes power; institutional co-membership becomes dependence; spatial proximity becomes a field relation; synchronized change becomes coupling. Such upgrades can be correct, but each requires an inferential bridge. The problem is not relational vocabulary itself. The problem is the disappearance of the evidential work needed to move from a weak relation to a stronger one.

Definition 24.496 (Relational saturation condition). A *relational saturation condition* is reached when the operative meaning of relation has expanded so broadly that serious rival accounts cannot be excluded because material properties, legal rules, institutional positions, technical constraints, intrinsic characteristics, and ordinary co-occurrence are all redescribed as instances of the same relational explanatory category.

Relational saturation weakens rather than strengthens GRE. It removes the possibility that a non-relational or mixed explanation might outperform a relational one. Section 24.5 therefore matters diagnostically: boundary, scale, identification, persistence, field, higher-order, and missingness checks are not optional refinements after a relational conclusion has already been reached. They are part of determining whether the relational conclusion is warranted.

Proposition 24.497 (Relational-overreach correction condition). *When a GRE explanation gains little discriminatory power from its relational specification, the appropriate correction is to narrow the relation, compare serious alternative mechanisms, or adopt a mixed explanatory architecture; semantic expansion of relation should not be used to make every alternative mechanism relational by definition.*

Repeated relational saturation across substantively different domains would be more serious than one local misclassification. It would indicate that relationality functions primarily as a redescriptive language rather than an explanatory constraint, and should therefore enter the counterevidence analysis developed in the next section.

24.20.2 Generativity Overreach

Generativity is central to GRE because the framework studies how economic configurations produce later capabilities, relations, values, institutions, and possibilities. Its importance creates a corresponding failure risk: processes can be described as generative simply because something valuable, persistent, or novel appears later. Section 24.18 already showed why empirical generativity requires mechanism discrimination. The present concern is broader: generativity can become an interpretive default that absorbs selection, revelation, transfer, conversion, persistence, redistribution, and adaptation.

Definition 24.498 (Generative attribution inflation). *Generative attribution inflation* occurs when the vocabulary of generation is applied to a later difference without adequate discrimination between genuine production of a new capacity, relation, value form, institution, or option and rival processes such as selection, revelation, persistence, transfer, conversion, redistribution, or measurement change.

The risk is amplified by positive connotations. In ordinary language, generation can suggest creativity, growth, or improvement. GRE explicitly rejects that implication: harmful dependence, exclusionary institutions, ecological degradation, surveillance capacity, or domination can also be generated. Yet even this broader use can become too permissive if every causal consequence is described as generative.

Definition 24.499 (Generative specificity test). A *generative specificity test* asks whether the analysis independently identifies what is generated, what did not previously exist in the relevant sense, which mechanism produces it, which conditions enable or maintain it, which rival processes can produce similar manifestations, and what evidence would reduce the claim from generation to contribution, transfer, persistence, conversion, or association.

A further failure mode is generative chaining without evidence. One relation is said to generate a capacity, which generates value, which generates institutions, which generates later option spaces. Long generative chains can be theoretically plausible while empirical support is strong only for the endpoints. The chain should therefore preserve link-specific warrant and uncertainty rather than inheriting confidence automatically from the surrounding theory.

Proposition 24.500 (Generativity-overreach restraint). *GRE should reserve generative language for claims that identify a typed generated object and a supported production mechanism; where the evidence supports only persistence, transfer, enablement, conversion, association, or contribution, the weaker description is analytically preferable to preserving generative vocabulary by semantic broadening.*

24.20.3 Formal Overreach

Formal overreach arises when the precision of a representation is mistaken for precision in the represented object. Section 24.7 distinguished schematic, structural, analogical, and empirically parameterized formalisms. The failure mode appears when these epistemic statuses blur: a useful diagram is read as a causal model, an elegant structural analogy acquires ontological authority, a parameter receives an empirical interpretation it cannot support, or a mathematically closed system is treated as substantively closed.

Definition 24.501 (Formal-warrant mismatch). A *formal-warrant mismatch* occurs

when the inferential strength attributed to a mathematical object, parameter, structure, or result exceeds the independently justified semantics, closure conditions, empirical identification, or correspondence between the formal system and the GRE object being represented.

Formal overreach can be subtle because the resulting model may be internally impeccable. A theorem can be correct under assumptions that are poorly matched to the empirical system. A complex-valued history representation can be mathematically coherent while the meaning of its phase remains unspecified. A 2-complex can preserve some historical structure while omitting institutional semantics that drive the economic outcome. Internal formal validity and external analytical adequacy are therefore distinct.

Definition 24.502 (Elegance-substitution failure). An *elegance-substitution failure* occurs when simplicity, symmetry, unification, mathematical richness, or formal tractability functions as a substitute for independent evidence that the representation preserves the mechanisms or distinctions required by the substantive claim.

The correction is not anti-formal. Strong formalization can reveal hidden assumptions, derive consequences, expose inconsistency, and organize complex relational structure. The correction is to keep an explicit bridge between formal objects and the empirical or conceptual distinctions they represent, together with an account of what the formalism omits.

Proposition 24.503 (Formal-downscaling principle). *When additional formal structure does not add empirically or conceptually discriminating consequences, GRE should lower the evidential status of the formal claim or simplify the representation rather than treating mathematical richness as independent support for the represented mechanism.*

24.20.4 Historical Overreach

Historical overreach occurs when GRE's historical sensitivity becomes rhetorical rather than reconstructive. A theory can mention path dependence, context, history, or multiple timescales while still projecting current categories backward, compressing intermediate contingencies, treating surviving institutions as inevitable, or transporting a mechanism across periods without checking whether its constitutive conditions remained stable.

Definition 24.504 (Historical-scope leakage). *Historical-scope leakage* occurs when a claim warranted for one historical configuration, category regime, temporal scale, or institutional period is extended to another without an explicit bridge establishing which objects, mechanisms, and meanings remain sufficiently comparable.

Historical overreach can also enter through causal narratives. Once an outcome is known, earlier institutions can appear to have been oriented toward producing it. GRE's generative vocabulary can unintentionally intensify this risk by encouraging narratives in which earlier relations are reconstructed mainly in terms of what they later generated. Section 24.6 therefore requires contemporaneous possibility structures, failed alternatives, archival limits, and category genealogies.

Definition 24.505 (Generative hindsight bias). *Generative hindsight bias* is the retrospective interpretation of an earlier relation, institution, or event primarily through the later objects it helped produce, in a manner that understates unrealized alternatives, contemporaneous uncertainty, later maintenance, substitution, and interven-

ing causes.

Historical generalization can remain legitimate. A mechanism can recur across periods, and historical comparison can reveal robust constraints or patterns. The failure mode lies in treating recurrence of labels, institutions, or outcomes as evidence that the same mechanism persisted unchanged.

Proposition 24.506 (Historical-overreach correction condition). *A GRE historical claim should be narrowed, retyped, or periodized when its explanatory mechanism depends materially on categories, institutional conditions, timescale separations, or possibility structures that are not stable across the periods being compared.*

24.20.5 Normative Overreach

Normative overreach occurs when a descriptive GRE property is allowed to function as an unstated evaluative standard. The most recurrent risks are now familiar: generativity becomes goodness, stability becomes desirability, option expansion becomes welfare, participation becomes legitimacy, economic capability becomes justice, compensation becomes repair, and practical settlement becomes normative resolution. Section 24.19 showed why each inference requires additional normative premises.

Definition 24.507 (Normative-premise concealment). *Normative-premise concealment* occurs when a substantive priority, standing rule, baseline, threshold, aggregation rule, right, or procedural commitment is embedded in GRE terminology, metrics, or decision criteria without being identified as an independent normative premise.

The failure mode can appear in formally neutral language. A model that optimizes generative capacity can privilege particular kinds of capacity; an option-space metric can treat more options as better; a resilience measure can privilege persistence; a conversion-efficiency criterion can ignore residual value; a participation score can count presence rather than consequential voice. The normative choice has not disappeared. It has moved into the representation.

Definition 24.508 (Settlement-as-justice failure). *A settlement-as-justice failure* occurs when an institutional outcome, market exchange, negotiated agreement, vote, legal resolution, administrative procedure, or operational compromise is treated as establishing justice merely because it settles action or coordinates expectations.

False neutrality is the mirror image. GRE can overreach normatively by making hidden judgments, but it can also fail by refusing to identify the normative assumptions already built into institutions, property arrangements, metrics, or policy baselines. Normative openness therefore requires explicitness rather than silence.

Proposition 24.509 (Normative-overreach correction condition). *Where a GRE conclusion depends on a claim about goodness, justice, legitimacy, acceptable burden, standing, or priority, the independent normative bridge and its domain-specific authority should be stated; if that bridge remains contested, the economic analysis should preserve conditional or plural normative conclusions rather than convert institutional settlement or descriptive advantage into final normative authority.*

24.20.6 Methodological Overreach

GRE is methodologically plural, but pluralism can itself fail in two ways. A preferred method can dominate because it fits the theorist's training or the framework's vocabu-

lary rather than the research object. Alternatively, multiple methods can be displayed ceremonially without being allowed to challenge one another. The relevant standard is not methodological variety but inferential fit.

Definition 24.510 (Method-object mismatch). A *method-object mismatch* occurs when a method's observability assumptions, unit of analysis, temporal resolution, manipulability requirements, representational categories, or inferential strengths are poorly aligned with the GRE object or claim for which the method is used.

Examples include estimating a stable scalar parameter for a rapidly changing institution; inferring latent relations solely from cross-sectional indicators; using narrative evidence to support a precise quantitative effect without an adequate bridge; using network topology to infer relation semantics; or using a formal model to replace rather than organize empirical inquiry. None of these method families is intrinsically inappropriate. The mismatch is claim-specific.

Definition 24.511 (Methodological confirmation asymmetry). *Methodological confirmation asymmetry* occurs when evidence generated by one method is accepted readily when it supports a GRE claim but dismissed as method-limited when it challenges the claim, without a symmetric standard established in advance.

This asymmetry is especially dangerous in a plural programme because conflicting findings can always be attributed to the limitations of the inconvenient method. Genuine pluralism requires pre-specified or at least transparently reconstructed reasons for weighting different evidence and explicit treatment of disagreement among methods.

Proposition 24.512 (Methodological-overreach correction condition). *Method selection in GRE should be governed by the local inferential task, and disagreement among credible methods should be treated as evidence about the object, assumptions, scale, or observability unless an independently justified reason establishes why one method is inapplicable.*

24.20.7 Domain Overreach

Domain overreach occurs when the portability architecture of Chapter 23 is bypassed. GRE concepts can illuminate neighboring domains, but economic incidence does not confer legal, political, ecological, educational, historical, technical, social, or aesthetic authority. A concept can travel successfully while changing its meaning, and an economically consequential relation can remain principally constituted by another domain.

Definition 24.513 (Domain-annexation failure). A *domain-annexation failure* occurs when GRE treats a neighboring-domain object, predicate, validity condition, or normative judgment as if its economic consequences or relational representation were sufficient to reconstruct the object exhaustively within GRE.

Domain annexation can occur outward or inward. Outwardly, GRE can redescribe education as capability production, law as incentive structure, ecology as resource constraint, politics as power conversion, or AI as economic agency while suppressing receiving-domain distinctions. Inwardly, GRE can import a legal, ecological, political, educational, or technical premise and then forget that the premise remains externally warranted and revisable.

Definition 24.514 (Correction-authority bypass). A *correction-authority bypass* oc-

curs when a GRE claim materially depends on a neighboring-domain premise but the analysis no longer records the source domain's authority to revise, reject, or retype that premise and the GRE conclusions that depend upon it.

The failure is not interdisciplinarity. It is one-directional interdisciplinarity in which GRE can borrow or export but cannot be corrected. Sections 24.16 and Chapter 23 established the opposite principle: domain interfaces should be reciprocal and provenance-preserving.

Proposition 24.515 (Domain-overreach correction condition). *When a GRE claim depends materially on a neighboring domain's object, validity standard, empirical premise, or normative judgment, the receiving or source domain should retain claim-specific correction authority, and translation success should not be interpreted as evidence that the economic representation exhausts the domain object.*

24.20.8 Conceptual Inflation

Conceptual inflation can protect the preceding failure modes. Terms such as relation, field, generativity, value, conversion, circulation, power, spacetime, participation, and manifestation can acquire ever wider extensions until coverage increases while discrimination falls.

Definition 24.516 (Conceptual inflation). *Conceptual inflation* is expansion of a GRE concept such that increasingly heterogeneous phenomena fall within it while its exclusion conditions, rival classifications, or discriminating implications weaken.

Conceptual change is not itself inflationary. The diagnostic issue is whether an extension adds a principled subtype or mechanism, or mainly protects the concept from counterexample. Broad concepts can remain useful when their internal typing is strong; the failure is semantic elasticity without corresponding analytical gain.

Definition 24.517 (Discriminatory depletion). *Discriminatory depletion* occurs when a concept can classify many cases but no longer yields sufficiently specific contrasts, exclusions, reconstruction requirements, or revision conditions to distinguish its use from serious alternatives.

Repair can involve narrowing, retyping, decomposition, regionalization, or retirement. An open research programme should not require inherited GRE vocabulary to survive merely because later claims have been stated through it.

Definition 24.518 (Concept-retirement condition). *A concept-retirement condition* is reached when repeated specification leaves a concept either too broad to discriminate among serious alternatives or so narrow that an established concept performs the same work more clearly and with fewer auxiliary assumptions.

The taxonomy therefore culminates in escalation. Local errors warrant local correction; recurrent errors warrant revision of definitions, methods, interfaces, or formalism. Persistence across applications after those repairs creates pressure on the relevant framework component.

Definition 24.519 (Failure-mode escalation record). *A failure-mode escalation record* tracks recurrence across applications, repairs already attempted, remaining auxiliary assumptions, domains in which the defect persists, and the evidence required to treat the problem as a challenge to the relevant GRE component.

Proposition 24.520 (Diagnostic escalation principle). *A recurrent GRE failure mode should not remain classified as local misuse when it persists under explicit definitions,*

appropriate methods, receiving-domain correction, and serious rival comparison; continued failure after those safeguards should enter explicit counterevidence and revision analysis.

The taxonomy is therefore transitional. It identifies characteristic ways GRE can go wrong while leaving open whether a particular failure is local, recurrent, or framework-level. The next section asks the stronger question of what should count positively against GRE rather than merely invite another qualification.

24.21 Evidential Defeat Conditions in GRE

The preceding section identified recurrent ways in which Generative Relational Economics (GRE) can exceed its warrant. The present section asks a stronger question: under what conditions should evidence count positively against a GRE claim, a GRE concept, or a component of the GRE research programme? The objective is not to manufacture a single falsification rule for a heterogeneous and partly interpretive framework. It is to prevent the opposite failure, in which every adverse result is reclassified indefinitely as a local exception, a missing variable, a domain peculiarity, or a problem of application. The section therefore develops claim-specific defeat conditions for relational explanation, generative distinction, value-conversion analysis, multiscale analysis, rival explanation, domain transfer, replication, and internal consistency. The method is comparative and escalation-sensitive: counterevidence is assessed against the exact claim it bears upon, after reasonable specification and correction have been attempted, and stronger implications require recurrence across appropriately varied settings.

Definition 24.521 (GRE evidential defeat profile). *A GRE evidential defeat profile* identifies the claim under test, its declared scope, the evidence and assumptions supporting it, serious rival explanations, observations or arguments that would lower its warranted status, repairs already attempted, and the level at which unresolved counterevidence would require local withdrawal, concept revision, programme revision, or a broader challenge to GRE.

This profile separates defeat from disappointment. An intervention that performs poorly can fail for implementation reasons while leaving the underlying mechanism intact. A relational hypothesis can fail in one population because the relation is absent there while remaining well supported elsewhere. Conversely, repeated success under weak tests cannot protect a claim when stronger discriminating tests systematically favour a rival. GRE should therefore attach defeat conditions to the inferential content actually asserted rather than to the prestige or centrality of the vocabulary in which it is expressed.

Definition 24.522 (Counterevidence locality). *Counterevidence locality* is the principle that adverse evidence should initially be assigned to the narrowest GRE claim whose evidential bridge it directly undermines, while propagation to broader concepts or framework commitments requires an explicit account of shared assumptions, recurrent failure, or logical dependence.

Locality prevents one failed application from being narrated as the collapse of an entire programme. It also prevents the reverse manoeuvre in which framework-level problems are fragmented into an endless sequence of unrelated local errors. The central task is to track when recurrence changes the level of the problem.

Table 24.21: Evidential defeat families and their primary GRE targets.

Evidence family		Primary GRE target	Stronger implication when recurrent
Relational	explanatory failure	Claimed explanatory role of a specified relation	Relational specification adds little discrimination beyond rival or mixed accounts
Generative	distinction failure	Separation of generation from transfer, selection, persistence, revelation, or conversion	Generativity category requires narrowing, retyping, or retirement in the affected domain
Conversion-analysis	failure	Typed source–interface–target mechanism	Conversion vocabulary fails to outperform simpler transmission or co-change accounts
Multiscale	failure	Claimed cross-scale bridge, aggregation, or emergence relation	Scale-transfer rules or level architecture require revision
Superior rival	explanation	Mechanism, model, or conceptual account under comparison	GRE component loses explanatory priority within the declared scope
Domain	counterexample	Portability or domain-interface claim	Transfer scope contracts; recurrent failures can defeat a purported cross-domain invariant
Empirical	non-replication	Empirical regularity or mechanism claim	Transportability, mechanism stability, or measurement architecture requires revision
Internal	inconsistency	Compatibility among GRE commitments	Core vocabulary, inference rules, or architecture requires reconciliation or abandonment

Definition 24.523 (Defeat escalation threshold). A *defeat escalation threshold* is reached when counterevidence persists across appropriately specified applications, survives reasonable repairs, recurs under methods capable of detecting the proposed mechanism, and targets assumptions or inferential bridges shared by a wider GRE component rather than one incidental implementation.

Table 24.21 summarizes the evidential families developed in this section. The table does not assign automatic verdicts. It identifies what must become harder to explain away if GRE is to remain an answerable research programme.

24.21.1 Persistent Failure of Relational Explanations

Relationality is central to GRE, but a central commitment should face correspondingly strong tests. A relational explanation claims more than the existence of social, institutional, historical, material, or technical connections. It claims that a specified relation, relational configuration, or history-bearing position contributes explanatory discrimination to the phenomenon under study. Persistent failure occurs when that contribution cannot be established even after boundary, scale, semantics, persistence, and missingness have been examined carefully.

Definition 24.524 (Relational defeat comparison). A *relational defeat comparison* evaluates a GRE relational explanation against at least one serious non-relational or

mixed rival under a common target, evidential base, scope, and outcome criterion, while preserving differences in complexity, observability, and auxiliary assumptions.

The relevant criterion is not merely predictive fit. A relational model can fit well because it contains a flexible representation of context, while a simpler institutional, material, technical, or compositional account identifies the operative mechanism more directly. Conversely, a non-relational model may predict accurately while a relational reconstruction better explains intervention sensitivity or historical change. Defeat therefore concerns the inferential task actually claimed: description, mechanism identification, counterfactual explanation, historical reconstruction, intervention, or transport.

Definition 24.525 (Persistent relational explanatory failure). *Persistent relational explanatory failure* occurs when, across appropriately varied cases and after explicit relational specification, GRE relational accounts repeatedly fail to add reliable discrimination, mechanism reconstruction, counterfactual leverage, or transportability beyond serious non-relational or mixed alternatives.

One isolated superiority result for a rival is insufficient. More serious evidence would include repeated findings that relation semantics do not survive direct measurement, relational variables cease to matter when relevant material or institutional mechanisms are represented, intervention on the alleged relation does not alter the predicted consequences, or relational reconstructions produce no stable implications not already available from simpler accounts.

Proposition 24.526 (Relational defeat condition). *If relational specifications repeatedly lose their claimed explanatory advantage under serious comparison after boundary, scale, semantics, missingness, and mixed-mechanism checks, GRE should lower the status of relational priority for that class of phenomena rather than broaden the meaning of relation until the rival explanation is redescribed as relational.*

The implication can remain domain-bounded. GRE need not abandon relational analysis because it fails for one class of objects. But persistent failure across distinct domains would bear on the broader claim that relational organization is a privileged explanatory starting point rather than one useful analytical option among others.

24.21.2 Failure of Generative Distinctions

GRE gives special analytical weight to generation: the production of later capacities, relations, value forms, institutions, roles, or possibilities that cannot be adequately represented as simple transfer or persistence. This distinction is valuable only if it can exclude neighbouring processes in practice. A vocabulary that labels any consequential historical change as generative would be too permissive to carry explanatory force.

Definition 24.527 (Generative discriminability test). A *generative discriminability test* asks whether the evidence and conceptual typing can distinguish the proposed generation from serious alternatives such as transfer, conversion, revelation, selection, persistence, recombination, redistribution, reclassification, substitution, or measurement change.

The test can be conceptual, empirical, historical, or formal. For example, a capability said to have been generated should not have been merely latent and newly observed; a relation said to have been generated should not be a reclassification of

an earlier relation under changed terminology; a new value form should not be a renamed manifestation of an existing form unless the distinction is analytically warranted.

Definition 24.528 (Generative category collapse). *Generative category collapse* occurs when recurrent GRE applications cannot identify stable exclusion conditions separating generation from adjacent process types, so that the generative label contributes little beyond the observation that a later state differs from an earlier one.

Generative category collapse would be stronger counterevidence than occasional ambiguity. Historical processes often combine generation, conversion, transfer, and persistence. The problem arises when even carefully selected cases with process evidence cannot sustain the distinction, or when the classification depends principally on whether the analyst regards the later outcome as novel or important.

Proposition 24.529 (Generative defeat condition). *When repeated applications with adequate process evidence cannot distinguish generation from serious neighbouring mechanisms, the relevant GRE generativity claim should be narrowed or retyped; if the failure recurs across core domains, the generativity architecture itself requires programme-level reconsideration.*

The evidential burden is therefore asymmetric in a useful way. GRE need not show that every historical novelty has one pure mechanism. It must show that calling a process generative adds a discriminating claim that could have been false.

24.21.3 Failure of Value-Conversion Analysis

Value conversion is one of GRE's most distinctive substantive claims: heterogeneous value forms can be connected through interfaces and conditions without assuming prior equivalence. Section 24.11 established a demanding identification architecture for such claims. The present issue is what would count against that architecture rather than merely make one conversion estimate uncertain.

Definition 24.530 (Conversion defeat profile). A *conversion defeat profile* records whether source and target forms remain stably typed, whether an interface can be independently reconstructed, whether intermediate transformation evidence exists, whether source-side and target-side changes behave as predicted, and whether simpler rival mechanisms explain the same observations with fewer unsupported assumptions.

A conversion claim weakens when source and target types shift whenever empirical patterns change, when the alleged interface cannot be distinguished from ordinary transfer or institutional recognition, or when observed target changes persist after source exposure is removed and are better explained by target-side generation or common causes. It also weakens when multiple incompatible conversion narratives fit the same evidence and no discriminating observation can be specified.

Definition 24.531 (Conversion analytical redundancy). *Conversion analytical redundancy* occurs when a proposed value-conversion account yields no reliable explanatory or empirical discrimination beyond a simpler account of transfer, co-production, recognition, pricing, substitution, or correlated change.

Redundancy would not show that value forms are homogeneous. It would show that the conversion mechanism claimed by GRE is not doing independent analytical work in the affected setting.

Proposition 24.532 (Value-conversion defeat condition). *If well-specified source–interface–target analyses repeatedly fail to distinguish conversion from serious rivals, or if the required value typing changes ad hoc to preserve the mechanism, GRE should withdraw or narrow the conversion claim rather than treat heterogeneous endpoint change as conversion by default.*

A stronger programme-level problem would arise if conversion analysis repeatedly adds complexity without improving mechanism identification across domains central to GRE's value architecture. That result would not imply that values are commensurable; it would imply that the present conversion formalism is an inadequate way to represent their interaction.

24.21.4 Failure of Multiscale Claims

GRE frequently moves among persons, organizations, institutions, communities, political economies, infrastructures, ecological systems, and historical trajectories. Such movement is analytically useful only when cross-scale relations are reconstructed rather than assumed. A pattern at one scale does not automatically aggregate upward, and a macro-level pattern does not automatically decompose into the same mechanism at lower levels.

Definition 24.533 (Multiscale bridge claim). *A multiscale bridge claim specifies how a GRE property, mechanism, or state at one analytical scale is expected to compose, mediate, transform, constrain, or emerge at another scale, including the aggregation or disaggregation rule and the conditions under which it is expected to hold.*

Counterevidence includes systematic ecological or atomistic fallacies, non-reproducibility of individual-level mechanisms at institutional scale, macro-patterns that persist despite reversal of the proposed micro-mechanism, or scale-dependent category changes that invalidate the assumed bridge. A relation can change meaning across scales; so can power, participation, value, generativity, and resilience.

Definition 24.534 (Scale-coherence failure). *A scale-coherence failure occurs when a GRE cross-scale claim cannot maintain a justified bridge between levels because aggregation, decomposition, mediation, or emergence behaves systematically differently from the stated mechanism.*

Scale-coherence failure does not require that all scales share one ontology or metric. It requires the claimed bridge to survive its own assumptions. If GRE asserts that individual capability generation aggregates into institutional capability, for example, then coordination, substitution, distribution, organizational rules, and collective-action mechanisms become part of the bridge rather than removable detail.

Proposition 24.535 (Multiscale defeat condition). *Repeated scale-coherence failure should lower the warranted scope of the relevant cross-scale GRE claim; where such failures recur across multiple core concepts, GRE should revise its multiscale architecture rather than infer higher- or lower-level mechanisms from formal similarity alone.*

24.21.5 Superior Rival Explanations

A research programme should be corrigible not only by direct contradiction but by better explanation. GRE therefore needs a way to recognize when a rival account provides stronger explanatory performance within a declared scope. Rival superi-

ority cannot be reduced to one metric because explanatory tasks differ, but neither should GRE protect itself by changing the criterion whenever a rival performs better.

Definition 24.536 (Rival-explanation superiority profile). *A rival-explanation superiority profile compares GRE and a serious rival with respect to the inferential task at issue, empirical discrimination, mechanism specificity, predictive or retrodictive adequacy where relevant, intervention sensitivity, historical fit, transportability, conceptual clarity, auxiliary assumptions, and capacity to accommodate counterevidence without semantic expansion.*

Parsimony alone is not decisive. A richer GRE reconstruction can be warranted when the additional relational or historical structure yields new discrimination. Conversely, complexity becomes a liability when it mainly absorbs exceptions. Rival superiority is therefore strongest when the rival explains the observations at least as well while specifying clearer mechanisms, making riskier successful predictions, requiring fewer ad hoc repairs, or travelling more reliably across the relevant conditions.

Definition 24.537 (Explanatory replacement pressure). *Explanatory replacement pressure arises when a rival explanation repeatedly dominates the GRE account on the criteria material to the stated research objective and the GRE account cannot recover its claimed advantage through independently justified specification.*

Replacement pressure can be local. GRE can remain useful as a descriptive, normative, historical, or interface language even when another theory explains a particular mechanism better. But an open programme should acknowledge the division of explanatory labour rather than insist that every economically relevant mechanism be reconstructed as distinctively GRE.

Proposition 24.538 (Rival-superiority defeat condition). *Where a serious rival repeatedly explains the same target with greater discriminating power, clearer mechanism, stronger transport, or fewer unsupported auxiliary assumptions, the corresponding GRE claim loses explanatory priority within that scope unless GRE can identify an independently warranted contribution not supplied by the rival.*

24.21.6 Domain-Specific Counterexamples

Chapter 23 and Section 24.16 made cross-domain correction part of GRE's architecture. A receiving domain can therefore supply evidence that an exported GRE concept changes meaning, misses constitutive structure, or produces false inference. Such counterexamples should narrow portability rather than be dismissed as insufficiently economic.

Definition 24.539 (Domain-specific counterexample). *A domain-specific counterexample is a receiving-domain case in which a GRE concept or cross-domain candidate, applied under its stated transfer conditions, yields a false, misleading, non-discriminating, or constitutionally incomplete inference according to independently warranted domain evidence.*

One failed transfer usually defeats a portability claim, not the originating GRE concept. An economic notion of participation can remain useful economically even if it fails to capture political participation. A conversion framework can remain useful in markets while proving inadequate for ecological restoration. The escalation question is whether the failure targets a local translation rule or a purportedly general structure.

Definition 24.540 (Counterexample propagation map). A *counterexample propagation map* identifies which GRE export, cross-domain candidate, or underlying GRE premise is affected by a domain-specific counterexample and which neighbouring claims remain independent of that failure.

This map protects both openness and restraint. It prevents a receiving domain from being treated as a mere application field, but it also prevents every failed transfer from being narrated as evidence against GRE's economic core.

Proposition 24.541 (Domain-counterevidence condition). *When independently warranted receiving-domain evidence repeatedly rejects the structure required by a GRE transfer claim, the transfer scope should contract; recurrence across semantically independent domains can count against a purported cross-domain invariant even when the originating economic concept remains locally adequate.*

24.21.7 Empirical Non-Replication

Replication is especially difficult for GRE because many claims are historical, relational, context-sensitive, and mechanism-specific. Context sensitivity, however, cannot be allowed to make non-replication irrelevant by definition. The relevant question is what kind of stability the original claim asserted and whether the replication design preserves the conditions required to test that stability.

Definition 24.542 (GRE replication profile). A *GRE replication profile* records the original claim, target mechanism, measurement and representation choices, relational and institutional conditions, historical regime, replication design, preserved and changed scope conditions, and the inferential implication of convergence or divergence between studies.

Replication can be exact where records and procedures permit, conceptual where the mechanism is instantiated differently, multi-site across contemporaneous contexts, or historical across regimes. No form is automatically superior. Exact replication can reproduce the same measurement bias; conceptual replication can test portability but change too many conditions; historical replication can reveal regime dependence but rarely reproduces identical interventions.

Definition 24.543 (Non-replication escalation condition). A *non-replication escalation condition* is reached when adequately powered or evidentially rich replications that preserve the relevant scope conditions repeatedly fail to recover the GRE pattern or mechanism, while plausible measurement, implementation, and contextual explanations for the divergence have been examined and do not account for the result.

Non-replication can therefore produce several revisions: narrowing transportability, changing measurement, retyping the mechanism, adding a genuine moderator, or abandoning the claim. The repair becomes problematic when a new moderator is introduced after every failure without independent evidence.

Proposition 24.544 (Replication defeat condition). *Repeated, well-diagnosed non-replication should lower the warranted status of the affected GRE empirical claim, and unexplained recurrence across settings that were within its declared scope should count as counterevidence rather than be absorbed indefinitely through post hoc contextual qualification.*

24.21.8 Internal Inconsistency

GRE can also face counterevidence from within its own architecture. A framework assembled across ontology, epistemology, value theory, power, justice, formalism, and praxis can contain commitments that cannot all be maintained simultaneously. Internal inconsistency is not empirical falsification, but it can undermine the inferential legitimacy of conclusions derived from incompatible premises.

Definition 24.545 (GRE internal-consistency audit). A *GRE internal-consistency audit* identifies commitments that jointly constrain the same claim and tests whether their definitions, typing rules, scope conditions, inferential roles, and revision principles can be satisfied simultaneously without equivocation.

Potential tensions include ontological suspension combined with unqualified ontological language in formal models; value plurality combined with hidden scalar aggregation; domain containment combined with universal export of GRE concepts; normative underdetermination combined with unmarked substantive prescriptions; or methodological pluralism combined with asymmetric dismissal of inconvenient evidence. Some tensions are terminological and repairable. Others can require choosing between commitments.

Definition 24.546 (Architectural inconsistency). An *architectural inconsistency* exists when two or more GRE commitments that are jointly necessary for a class of claims cannot be maintained together under stable semantics and declared scope, so that preserving one requires weakening, retyping, or abandoning another.

A framework can tolerate open questions and incomplete formalization; it cannot treat contradiction as evidence of richness. The appropriate response is to localize the inconsistency, determine which claims depend on it, and revise at the least destructive level consistent with restored coherence.

Definition 24.547 (Consistency-repair hierarchy). A *consistency-repair hierarchy* orders candidate responses from clarification of terminology and scope, through retyping of claims and removal of auxiliary assumptions, to revision of a core concept or architectural commitment when weaker repairs do not restore coherent inference.

Proposition 24.548 (Internal-inconsistency defeat condition). *When a GRE conclusion depends on mutually incompatible commitments and the inconsistency cannot be removed through stable clarification, narrowing, or retyping, the affected conclusion loses warrant; recurrent architectural inconsistencies that require ad hoc exceptions constitute evidence for programme-level revision.*

The eight defeat families provide a bridge between limitation and revision. They do not establish that GRE is false as a whole, because GRE is a layered and revisable research programme rather than one indivisible proposition. They do establish that its components can lose warrant. The strongest counterevidence is therefore not a dramatic single anomaly, but a pattern in which a core GRE distinction repeatedly fails to discriminate, a rival repeatedly explains more with fewer unsupported assumptions, receiving domains independently reject a claimed invariant, empirical results do not replicate within declared scope, or the framework cannot maintain its own commitments coherently.

Proposition 24.549 (Programme-level counterevidence principle). *Counterevidence should be escalated from a local claim to a wider GRE component only when the defeated claims share the relevant assumption or inferential bridge, the adverse pattern recurs under appropriate tests and repairs, and preserving the component would otherwise*

require semantic expansion, asymmetric evidential standards, or accumulating ad hoc exceptions.

The next section asks which such patterns would require major revision of GRE's core architecture rather than local withdrawal, regionalization, or replacement of one analytical component.

24.22 Architectural Revision Conditions

Section 24.21 identified evidential defeat conditions that can lower the warrant of a GRE claim, mechanism, or component. The role of the present section is to specify a stronger threshold: when repeated defeat can no longer be handled adequately by local narrowing, retyping, domain restriction, replacement of one model, or retirement of one subsidiary concept, but instead requires revision of the architecture through which Generative Relational Economics organizes its objects and inferences. The objective is not to protect an inherited framework by making architectural revision remote. It is to distinguish proportionate revision from indiscriminate abandonment. The section therefore examines eight core architectures: ontological distinctions, manifestation, research and praxis, generative attribution, value plurality, power conversion, domain containment, and the book's core vocabulary. The method is dependency-sensitive. A major revision is warranted when recurrent failures target assumptions shared by a sufficiently broad class of claims and weaker repairs cease to restore stable discrimination, coherent inference, or empirical answerability.

Definition 24.550 (GRE architectural revision). A *GRE architectural revision* is a change to a core distinction, typing rule, dependency relation, inferential bridge, or organizing vocabulary whose alteration requires systematic reconsideration of multiple downstream GRE claims rather than correction of one application, model, domain transfer, or auxiliary assumption.

Architectural revision is therefore dependency-based rather than dramatic by definition. Replacing an elaborate formalism can remain local if few substantive claims depend on it. By contrast, revising the distinction between relational reality and manifestation may affect epistemology, empirical identification, model interpretation, historical reconstruction, and praxis even if the textual change is concise. The relevant quantity is the structure of dependence, not the rhetorical prominence of the concept.

Definition 24.551 (Major-revision threshold). A *major-revision threshold* is reached when a core GRE commitment is implicated in recurrent, independently supported defeat across materially different applications; reasonable local repairs have been attempted; preserving the commitment requires semantic expansion, incompatible exceptions, asymmetric evidential standards, or loss of discrimination; and revising the commitment would alter a substantial downstream claim family.

The threshold has both evidential and architectural components. A widely used concept does not require major revision merely because it is important, and repeated anomalies do not require it merely because they are numerous. The anomalies must bear on the shared commitment itself rather than on unrelated implementation defects. Conversely, a framework should not postpone architectural revision indefinitely by redescribing every recurrent challenge as context dependence.

Table 24.22 is diagnostic rather than exhaustive. Several architectural failures can

Table 24.22: Core GRE architectures and indicative conditions for major revision.

Architecture	Indicative recurrent failure	Architectural consequence if sustained
Ontological distinctions	Relational reality, manifestation, and suspended ontology cannot be applied with stable exclusion conditions or different inferential roles	Replace or reorganize the layered ontology and propagate the change through epistemology and formal interpretation
Manifestation framework	Manifestation relations cannot be reconstructed, compared, or distinguished from constitution, representation, or intervention across core cases	Rebuild the access architecture around another account of appearance, mediation, or co-constitution
Research–praxis boundary	Inquiry and intervention cannot be separated sufficiently for consequential claims, even with reflexivity and participation modeled explicitly	Replace the boundary with a unified epistemic–practical event architecture and revise evidential standards
Generative attribution	Generation repeatedly fails to discriminate from transfer, conversion, selection, revelation, recombination, or persistence across central applications	Reduce, decompose, or abandon generativity as GRE's principal process distinction
Value plurality	Typed heterogeneous value neither stabilizes empirically nor improves comparison relative to warranted common measures or better alternative classifications	Reconstruct the value architecture, including conversion, circulation, aggregation, and justice interfaces
Power conversion	Asymmetry, capacity, dependence, and control do not support stable mechanism-based transitions into the power relations claimed by GRE	Rebuild the power genealogy and its links to conversion, circulation, governance, and justice
Domain containment	Claim-specific economic jurisdiction and receiving-domain correction cannot be localized without persistent circularity or arbitrary boundary drawing	Replace domain containment with a different problem-space or interface architecture
Core vocabulary	Multiple foundational terms require recurrent semantic stretching, overlap, or retirement and no stable typing system restores discrimination	Re-found the vocabulary and systematically translate, revise, or withdraw dependent claims

occur together. A breakdown in the manifestation framework can weaken empirical identification; instability in value typing can undermine conversion and circulation; failure of domain containment can reveal that the core vocabulary changes meaning too strongly across domains to sustain the existing interfaces. Architectural revision should therefore trace dependency among failures rather than count them independently.

Definition 24.552 (Architectural revision dossier). An *architectural revision dossier* records the challenged commitment, affected claim family, independent defeat evidence, repairs already attempted, recurring exceptions, rival architectures, downstream dependencies, claims likely to survive revision, claims requiring re-derivation, and evidence that could discriminate among candidate replacements.

This dossier makes a major revision a research object rather than an act of theoretical preference. It also preserves continuity: a revised GRE need not discard every earlier result. Some empirical findings, historical reconstructions, or local mechanisms may survive even when the conceptual architecture through which they were first interpreted changes.

24.22.1 Ontological Layer Adequacy

GRE has relied on a restrained three-level orientation: ultimate ontology remains suspended; sufficiently persistent and causally efficacious configurations can be treated as relationally real; and those configurations become accessible through historically situated manifestations. Section 24.2 clarified that this architecture is methodological and explanatory before it is ontological. Major revision would nevertheless be required if the distinctions themselves repeatedly failed to support different inferential tasks.

Definition 24.553 (Ontological-layer discriminability). *Ontological-layer discriminability* is the capacity of GRE's ontological architecture to distinguish, for a declared research task, claims about ultimate constitution, claims about relatively stable relational reality, and claims about manifested or epistemically accessible presentation without shifting the same proposition among layers merely to preserve it from criticism.

The distinction would be weakened if a supposedly relationally real object could be identified only by the same manifestation whose adequacy was in question, if manifestations were treated as ontologically secondary when convenient but constitutive when contrary evidence appeared, or if ontological suspension coexisted systematically with substantive ontological conclusions imported through formal language. Occasional ambiguity is expected. The architectural concern arises when the layer assignment becomes an after-the-fact device rather than a stable inferential discipline.

A second challenge would arise from repeated evidence that the phenomena GRE analyzes are better reconstructed through ontological categories that do not map coherently onto the three-level architecture. Domain-specific material, biological, legal, technical, phenomenological, or ecological constitutions may sometimes require such categories locally. Major revision would become relevant only if the same problem recurred across core GRE objects and the layer architecture ceased to clarify what could be claimed, observed, or revised.

Definition 24.554 (Ontological-layer collapse). *Ontological-layer collapse* occurs when the distinctions among ontological suspension, relational reality, and manifestation fail recurrently to produce stable differences in evidential burden, explanatory role, or revision condition across the claims that depend on them.

Layer collapse would not by itself establish a competing ontology. It would show that GRE's present architecture no longer earns its complexity. Candidate revisions could include a graded ontology, a process ontology with explicit epistemic interfaces, a domain-indexed ontological architecture, or a less ontologically loaded theory of

analytical objects. The replacement should be judged by whether it restores discrimination without making stronger metaphysical claims than the evidence warrants.

Proposition 24.555 (Ontological architectural-revision condition). *When ontological-layer assignments repeatedly fail to constrain inference or revision after explicit typing and domain-specific testing, GRE should revise the layer architecture itself rather than preserve it through case-by-case reassignment; downstream claims that depend on relational-reality or manifestation status should then be re-derived under the replacement architecture.*

24.22.2 Manifestation Architecture Adequacy

The manifestation framework is more specific than general epistemic humility. It proposes that relational reality is not accessed without mediation and that the relation between a target and its manifestations is historically variable, potentially non-invertible, and sometimes performative. Section 24.4 developed this into a disciplined account of representation and reverse inference. Major revision would be necessary if manifestation ceased to be a useful middle category between relational reality and representation.

Definition 24.556 (Manifestation separability). *Manifestation separability* is the extent to which GRE can distinguish the process through which relational differences become available from the subsequent representation, classification, measurement, narration, or modelling of those available differences, while allowing the two processes to interact.

The distinction can fail in both directions. Some phenomena may be constituted through the very classificatory, symbolic, legal, or technical practices that make them observable, so that manifestation cannot be treated as a merely downstream presentation of a prior relational object. Conversely, some empirical settings may offer sufficiently direct operational access that a separate manifestation layer adds no explanatory discrimination beyond ordinary measurement and representation theory.

The stronger challenge concerns systematic non-reconstructability. A manifestation relation can be many-to-one or historically changing without being useless. It becomes architecturally problematic when no stable constraints can be placed on the class of target configurations compatible with observed manifestations, when manifestation changes cannot be distinguished from target change even under comparative evidence, or when the same evidence can be assigned freely to manifestation error or relational transformation depending on which preserves the GRE claim.

Definition 24.557 (Manifestation redundancy). *Manifestation-framework redundancy* occurs when a manifestation analysis repeatedly adds no inferential discrimination beyond a simpler representation, measurement, or constitutive-practice account, while introducing no independently testable bridge assumptions or revision conditions.

A replacement framework might treat appearance and representation as one mediated epistemic process, model target and manifestation as jointly constituted in some domains, or retain manifestation only for cases where it performs identifiable analytical work. Major revision need not require uniform treatment across domains; it may instead require GRE to abandon the assumption that one manifestation architecture travels across all economic objects.

Proposition 24.558 (Manifestation architectural-revision condition). *If the manifestation layer recurrently cannot be distinguished from constitution or representation, or if it cannot support bounded reverse inference under cases where GRE depends on it, the framework should be decomposed, regionalized, or replaced rather than retained as a universal mediation layer.*

24.22.3 Research–Praxis Boundary Adequacy

GRE distinguishes inquiry from praxis because the warrants for describing a system are not identical to the warrants for intervening in it. The distinction also supports the book's separation between observation or readout and state-changing transformation. Yet reflexive social and economic systems complicate the boundary: measurement can alter incentives, classification can change standing, publication can change expectations, participatory inquiry can generate relations, and AI-mediated research can become operational infrastructure.

Definition 24.559 (Research–praxis boundary). The *research–praxis boundary* separates epistemic acts whose principal declared role is to investigate, represent, or evaluate a system from practical acts whose principal declared role is to alter its states, relations, institutions, allocations, or possibilities, while allowing that one event can have effects on both sides.

The boundary is therefore functional rather than metaphysically sharp. A survey can be principally research while changing salience; a pilot programme can be principally intervention while generating evidence; a legal classification can simultaneously represent and transform. These mixed cases do not defeat the distinction if the epistemic and practical roles, consequences, and responsibilities can still be typed separately.

Major revision would become necessary if, across central GRE settings, attempts to separate research from praxis systematically distort the object because inquiry itself is constitutive of the relations being studied, or because the evidential process and practical transformation form one inseparable event. In such cases the appropriate architecture may be a joint epistemic–practical event model rather than two domains connected by reflexive effects.

Definition 24.560 (Epistemic–practical inseparability). *Epistemic–practical inseparability* exists when the evidence-producing act and the materially relevant transformation are generated through the same mechanism such that attributing the event to research or praxis separately removes information necessary to explain its consequences, responsibilities, or evidential status.

This condition is stronger than ordinary observer effects. It would matter, for example, where an audit creates the compliance architecture whose effect is being measured, where participatory research generates the collective subject whose preferences are later recorded, or where predictive publication changes the market relation whose dynamics supposedly validate the prediction. The proper revision would preserve both epistemic and practical dimensions as jointly typed rather than treating one as noise around the other.

Proposition 24.561 (Research–praxis architectural-revision condition). *When central GRE objects repeatedly exhibit epistemic–practical inseparability and the existing research–praxis distinction cannot preserve causal attribution, evidential status, and responsibility simultaneously, GRE should replace the binary boundary with a joint event*

architecture while retaining explicit typing of epistemic and practical consequences.

24.22.4 Generative Attribution Adequacy

Generativity is the most distinctive process commitment of GRE. The framework is organized around the possibility that economic processes do not merely allocate existing resources or transfer existing value but generate capacities, relations, institutions, value forms, roles, and future possibilities. Sections 24.11, 24.12, and 24.18 have imposed increasingly demanding mechanism and identification burdens on those claims. Architectural revision would be required if generation itself failed as a stable process category.

Definition 24.562 (Generative-core adequacy). *Generative-core adequacy* is the capacity of the GRE generativity architecture to identify a class of processes whose explanatory content cannot be reduced, without material loss, to transfer, conversion, selection, revelation, recombination, persistence, redistribution, substitution, or reclassification.

Generativity can be mixed with these neighbouring processes and still remain distinctive. Education can reveal existing capability while generating new capability; institutions can recombine earlier elements while creating novel coordination possibilities; technological systems can transfer resources while generating new dependencies. The architectural issue is whether an independently meaningful generated object and mechanism can be identified after such mixtures are decomposed.

A major challenge would arise if repeated empirical studies found that alleged generation consistently decomposes into already available processes with no residual mechanism, or if the generated object can be identified only by retrospective novelty judgments. Another challenge would arise if different domains require such incompatible meanings of generation that no shared GRE process architecture remains after semantic reconstruction.

Definition 24.563 (Generative-core dissolution). *Generative-core dissolution* occurs when, after mechanism typing and serious rival decomposition, the residual class of processes requiring a distinct generative category becomes empirically empty, conceptually unstable, or too heterogeneous to sustain common inferential rules across GRE's central economic applications.

A revision could respond at several levels. GRE might regionalize generativity into narrower process families, subordinate it to a more general theory of historical transformation, or retain generation only as an empirical predicate rather than the framework's organizing economic perspective. Such revision would affect value generation, generative allocation, capability formation, generative spacetime, and parts of the power and justice architecture; it would therefore be major even if many local empirical results survived.

Proposition 24.564 (Generative architectural-revision condition). *If generation repeatedly adds no stable explanatory discrimination after decomposition against serious neighbouring processes across GRE's central domains, the framework should revise the generative core rather than preserve it through increasingly broad definitions of novelty or historical change.*

24.22.5 Value-Plurality Architecture Adequacy

GRE's value architecture is deliberately heterogeneous. It allows multiple value forms, conversion without prior equivalence, partial commensuration, residual value, and domain-specific evaluative authority. Sections 24.9 and 24.10 also made the taxonomy revisable. Major revision would become necessary if this plural architecture were persistently less adequate than either a warranted common measure or a different account of evaluative heterogeneity.

Definition 24.565 (Value-plurality architectural adequacy). *Value-plurality architectural adequacy* is the capacity of GRE's typed heterogeneous-value framework to preserve empirically and normatively consequential differences among value forms while supporting more discriminating analyses of realization, conversion, circulation, conflict, and justice than serious simpler or alternative value architectures.

Two opposite patterns could challenge the architecture. One would be strong evidence that apparently heterogeneous value forms are consistently representable through a common measure with stable semantics, acceptable loss, and superior predictive or practical discrimination across the targeted settings. GRE should not preserve plurality merely as a philosophical preference if the relevant distinctions do no work. The other pattern would be excessive instability: value forms might proliferate or shift so strongly that the taxonomy cannot support stable typing, conversion, or comparison and each application requires a new ontology of value.

Definition 24.566 (Value-plurality architecture failure). *Value-plurality architecture failure* occurs when typed value heterogeneity recurrently either adds no material discrimination beyond a warranted common representation or fails to provide stable enough value identities for the conversion, circulation, comparison, and justice claims that depend on it.

The revision need not choose between universal scalarization and unlimited plurality. Candidate replacements include a smaller set of context-indexed value families, multidimensional value spaces with explicit bridge rules, domain-specific value ontologies connected only by partial mappings, or process-centered accounts that treat some apparent value forms as stages of realization rather than distinct kinds.

Proposition 24.567 (Value-architecture revision condition). *When heterogeneous-value typing recurrently fails either through analytical redundancy or through instability that prevents downstream mechanism identification, GRE should revise the value architecture and re-evaluate conversion, circulation, aggregation, power, and justice claims that presuppose the affected value distinctions.*

24.22.6 Power-Conversion Architecture Adequacy

GRE develops power from typed asymmetry, historically situated capacity, relational realization, and mechanisms through which one position conditions another's economically relevant possibilities. Section 24.13 resisted both the claim that every asymmetry is power and the claim that only direct control qualifies. Major revision would be required if the pathway from asymmetry and capacity to realized power could not be reconstructed with stable mechanism types across central applications.

Definition 24.568 (Power-conversion architecture). The *power-conversion architecture* is the GRE account of how resources, positions, informational advantages, recognition, institutional roles, infrastructural control, timing, exit conditions, or other

typed asymmetries can, under identifiable relational conditions, become capacities that materially condition another position's feasible possibilities.

The phrase conversion does not imply conservation or one common power substance. It identifies a transition from an asymmetry or potential capacity into relationally realized conditioning. The architecture is challenged if those transitions cannot be distinguished from productivity differences, voluntary coordination, shared constraints, institutional rule-following, or third-party enforcement, or if the relevant mechanism varies so radically that one power genealogy obscures rather than clarifies the phenomena.

A further challenge concerns composition. GRE permits conversion power, circulation power, recognition power, infrastructural power, epistemic power, and other typed mechanisms to interact without requiring scalarization. If empirical analysis shows that these mechanisms do not share even a minimal relational kernel, or conversely that a simpler established power theory explains their transitions more coherently, the existing architecture may be unnecessary.

Definition 24.569 (Power-genealogy breakdown). *Power-genealogy breakdown* occurs when repeated GRE applications cannot establish a stable inferential path from typed asymmetry through credible capacity and mechanism to consequential relational conditioning, or when the proposed path adds no discrimination beyond serious alternative power accounts.

The appropriate response could be to separate several power families, make power fully domain-specific, revise the role of asymmetry as a precursor, or import a stronger external theory while retaining only GRE-specific analyses of economic incidence and value interfaces. Such revision would propagate into governance, justice, AI-era asymmetry, conversion, circulation, institutional analysis, and criticality-related applications.

Proposition 24.570 (Power architectural-revision condition). *If the asymmetry-capacity-mechanism-conditioning genealogy repeatedly fails to discriminate realized power from serious alternatives across central GRE applications, the power architecture should be re-founded rather than preserved by relabeling heterogeneous causal influence as power.*

24.22.7 Domain-Containment Architecture Adequacy

Chapter 23 treated GRE as a domain-specific research programme whose principal problem-space is economic while maintaining explicit interfaces with history, governance, law, political theory, education, ecology, AI studies, social theory, aesthetics, and other domains. Section 24.16 then made receiving-domain correction authority part of transfer discipline. This architecture presupposes that claim-specific economic jurisdiction can be identified even where empirical objects are shared.

Definition 24.571 (Domain-containment adequacy). *Domain-containment adequacy* is the capacity to identify a materially coherent economic problem-space, specify which predicates and inferences fall within GRE warrant, preserve neighboring-domain authority over their own predicates, and trace cross-domain dependencies without arbitrary or circular boundary assignment.

The architecture would be challenged if central GRE objects repeatedly turned out to be constitutively inseparable from legal, political, ecological, educational, social,

technical, or normative predicates such that economic claims could not be typed independently even provisionally. It would also be challenged if correction authority could not be localized because each domain's object was recursively constituted by all the others at the same inferential level.

This possibility should not be exaggerated. Interdependence does not imply domain collapse. A property regime can be jointly legal, political, social, and economic while still supporting different claim-specific questions. Major revision is warranted only when the distinction among problem-spaces ceases to constrain inference and the interface architecture becomes a bookkeeping device around an effectively undifferentiated object.

Definition 24.572 (Domain-containment breakdown). *Domain-containment breakdown* occurs when recurrent core cases cannot support stable claim-specific jurisdiction or provenance-preserving correction without arbitrary boundary placement, so that the distinction between GRE and its neighboring domains no longer organizes evidential or explanatory responsibility.

A replacement could organize inquiry around problems, mechanisms, or event complexes rather than disciplinary domains. GRE might then become one economic lens within a more explicitly multi-domain relational programme, or its concepts might be partitioned into several neighboring research programmes with no privileged economic center. Such a change would affect the programme's identity, not merely one export rule.

Proposition 24.573 (Domain-containment architectural-revision condition). *When claim-specific economic jurisdiction and correction authority cannot be stabilized across GRE's central objects despite explicit predicate typing, the framework should revise its domain-containment architecture rather than preserve disciplinary identity through arbitrary boundary assertions.*

24.22.8 Core-Vocabulary Re-Foundation

The strongest revision concerns GRE's vocabulary itself. Relation, generation, value, conversion, circulation, power, participation, field, spacetime, and manifestation organize much of the book, but they should remain revisable infrastructure rather than protected identity.

Definition 24.574 (Core-vocabulary stress). *Core-vocabulary stress* is recurrent reliance on semantic stretching, overlapping redefinitions, incompatible domain-specific meanings, or auxiliary distinctions to preserve claims a foundational term was intended to clarify.

New subtypes can reveal structure, but repeated qualifications may instead show that distinct objects or mechanisms were grouped under one label. Decomposition may then be preferable to further expansion.

Conceptual duplication creates the opposite pressure: if several GRE terms repeatedly collapse into one better-specified mechanism, the framework should permit merger rather than preserve terminology for continuity.

Definition 24.575 (Vocabulary re-foundation condition). *A vocabulary re-foundation condition* is reached when multiple core terms simultaneously exhibit discriminatory depletion, unstable typing, recurrent overlap, or clearer replacements, so that local redefinition would leave the wider inferential architecture inconsistent or opaque.

Re-foundation should preserve a translation record marking earlier claims as preserved, narrowed, retyped, decomposed, merged, or withdrawn.

Definition 24.576 (GRE architectural revision ladder). The *GRE architectural revision ladder* orders responses from local correction and narrowing through retyping, regionalization, component replacement, core-architecture revision, coordinated revision, and vocabulary re-foundation.

The ladder does not privilege minimal change; accumulated patches can become more ad hoc than revision of their shared commitment.

Proposition 24.577 (Proportionate architectural revision principle). *GRE should adopt the least extensive revision that restores stable semantics, empirical discrimination, coherent inference, and appropriate domain and normative authority; when local repair requires accumulating ad hoc exceptions, revision should escalate to the shared architecture on which the defeated claims depend.*

Major revision remains compatible with continuity when reasons are explicit and dependent claims re-evaluated. GRE should prioritize answerability over loyalty to a fixed ontology, vocabulary, or formalism. Section 568 develops this agenda.

24.23 Scope-Conditioned GRE Research Programme

Chapter 24 has treated limits as part of the substantive content of Generative Relational Economics rather than as qualifications appended after the theory has already been stated. The preceding sections identified distinct ontological, epistemic, manifestational, relational, historical, formal, value-theoretical, power-theoretical, normative, practical, cross-domain, AI-era, and empirical limits; they then specified recurrent failure modes, evidential defeat conditions, and circumstances that would require architectural revision. The role of the present section is to convert that critical record into a positive research programme while preserving the scope conditions that made the criticism meaningful. Its objective is not to repeat the broader research architecture developed earlier in the book, nor to anticipate the programme-wide synthesis of Chapter 25. It is narrower and more operational: each identified limit should become a question, research direction, collaboration point, defeat test, interface obligation, historical revalidation task, or candidate for future theory. The method is therefore limitation-derived programme construction. What GRE presently cannot establish becomes part of the specification of what future GRE research must learn to establish, distinguish, revise, or decline.

Definition 24.578 (Scope-conditioned research programme). A *scope-conditioned GRE research programme* is a versioned portfolio of questions, studies, formal developments, domain collaborations, replications, counterexample searches, historical revalidations, and theoretical revisions whose admissible claims remain explicitly bounded by the scope conditions, evidential defeat conditions, and architectural revision criteria established for the relevant GRE concepts.

The phrase *scope-conditioned* is essential. An open programme is not a programme in which any relational, generative, or value-related question can be incorporated without constraint. Openness requires identifiable entry conditions and exit conditions. A proposed extension should state which GRE object it develops, what evidence could improve or weaken the claim, which neighboring domain retains authority over imported premises, and how the result would affect dependent claims. The pro-

Table 24.23: Limitation-derived GRE research programme and corresponding scope discipline.

Limitation family	Priority research object	Scope discipline
Ontological and relational	Relational adequacy, non-relational remainder, layer discriminability, boundary and scale sensitivity	Do not infer ontological primacy from analytical usefulness
Epistemic and manifestational	Hidden relations, inverse problems, representation error, changing manifestation mappings	Keep access, manifestation, representation, and target claims distinct
Historical and formal	Category change, timescales, criticality, closure, parameter meaning, mathematical transfer	Treat validity as regime-bounded until historical and empirical bridges are tested
Value, conversion, and circulation	Value typing, commensuration, conversion mechanisms, transmission paths, capture, regeneration	Preserve non-equivalence and residual value unless independently resolved
Power and justice	Conditioning mechanisms, recognition, participation, power conversion, normative bridges	Separate descriptive power and incidence from normative authority
Applied praxis	Irreversibility, model risk, participation capacity, institutional feasibility, radical uncertainty	Match commitment strength to uncertainty, monitoring, reversibility, and repair capacity
Domain transfer and AI	Receiving-domain semantics, changing capabilities, infrastructure dependence, verification	Preserve external correction authority and claim-specific validity horizons
Empirical and architectural	Identification, replication, rival superiority, programme-level defeat, vocabulary stress	Escalate revision when recurrent defeat targets shared architecture

programme is open because its questions and formulations can change, not because its vocabulary is immune to exclusion.

Definition 24.579 (GRE scope-condition register). A *GRE scope-condition register* records, for each consequential claim family, the object and predicate under study, empirical and historical scope, operative definitions, necessary external premises, known limitations, current defeat conditions, revision dependencies, and the conditions under which the claim should be narrowed, retyped, suspended, or withdrawn.

The register gives future research a stable starting point without converting present formulations into canonical doctrine. A successful study may widen a scope condition, narrow it, decompose it, replace one bridge, or show that a previously excluded mechanism should be incorporated. A negative result may be equally informative if it identifies where a mechanism stops working. In this sense, Chapter 24 ends not by eliminating incompleteness but by making incompleteness researchable.

Table 24.23 summarizes the conversion from limitation family to research object and scope discipline. The table is not a priority ranking. Some questions are theoretically central but empirically immature; others are empirically tractable but conceptually

ally local. Programme design should preserve both kinds rather than rewarding only what is easiest to measure or most readily formalized.

24.23.1 Research Questions Generated by Identified Limits

A limitation becomes scientifically useful when it can be reformulated as a question whose possible answers would change a claim, a method, a scope condition, or a theoretical architecture. Merely restating uncertainty is insufficient. The research question should expose the missing discrimination. If relation identification is uncertain, the question is not simply whether relations matter, but which observable differences would distinguish trust from repeated interaction, dependence from co-membership, or power from ordinary asymmetry. If value conversion is uncertain, the question concerns which process evidence would distinguish conversion from transfer, co-generation, or reclassification. If historical generalization is uncertain, the question concerns which conditions must remain invariant for the proposed mechanism to travel across periods.

Definition 24.580 (Limitation-derived research question). A *limitation-derived research question* is a question generated by an identified boundary, uncertainty, limitation, open problem, failure condition, or architectural stress point and formulated so that materially different answers would imply different GRE claims, scope conditions, methods, or revisions.

This definition excludes questions whose answers cannot affect the framework. A question that merely asks for another illustration of an already accepted concept may extend coverage, but it does not directly address a limit. Limitation-derived questions should instead target a discriminating uncertainty: whether a relation persists across a boundary change, whether an apparent value gain survives a different value taxonomy, whether a field representation adds explanatory information beyond specified local mechanisms, whether power remains identifiable when direct control is absent, or whether a domain-transfer result survives reconstruction under receiving-domain semantics.

Definition 24.581 (Question-to-claim dependency). A *question-to-claim dependency* records which GRE claims would be strengthened, weakened, retyped, narrowed, or left unchanged under the serious answer classes to a limitation-derived research question.

Recording the dependency prevents open problems from becoming detached lists. It also identifies questions whose answers have disproportionate architectural consequences. For example, a local measurement problem may affect one empirical estimate, whereas evidence that the distinction between manifestation and representation cannot be maintained across central cases would propagate much further. Research priority can therefore depend partly on dependency depth rather than only on topical novelty.

Proposition 24.582 (Discriminating-question principle). A *limitation-derived GRE question has greater programme value when its serious answer classes discriminate among competing mechanisms, scope conditions, or architectural choices rather than merely increasing the number of cases describable in existing vocabulary.*

The principle does not imply that descriptive work is secondary. Rich description can reveal previously unknown objects and categories. It means that once a limitation has been identified, the associated research question should preserve the possibility

that GRE's present formulation is not the best one.

24.23.2 Limitation-Guided Research Directions

Questions become a research direction when they can be organized into cumulative sequences rather than isolated projects. The limitation architecture of this chapter suggests several such sequences. Relational research can move from relation identification to boundary sensitivity, persistence, higher-order structure, field reconstruction, and mixed explanatory comparison. Value research can move from value-form identification to commensurability, conversion, circulation, residual value, and justice. Historical research can move from reconstruction and category genealogy to timescale analysis, transportability, and revalidation of formal or substantive hypotheses. Formal research can move from schematic representation to semantic typing, identification, empirical parameterization, comparison with simpler models, and eventual abandonment where the added formal structure fails to discriminate.

Definition 24.583 (GRE research-direction packet). A *GRE research-direction packet* specifies a limitation-derived problem family, the present claim status, a sequence of discriminating questions, feasible empirical or formal designs, required domain expertise, expected negative-result value, dependencies among studies, and the criteria for widening, narrowing, or retiring the research direction.

The packet should distinguish foundational and downstream work. A sophisticated model of circulation may be premature if the underlying value forms and transmission semantics remain unstable. A justice comparison may be premature if the incidence of the intervention is poorly reconstructed. Conversely, waiting for complete foundations can indefinitely postpone useful empirical work. The appropriate ordering is therefore dependency-sensitive rather than strictly foundationalist.

Definition 24.584 (Research dependency bottleneck). A *research dependency bottleneck* is an unresolved claim or measurement problem on which several downstream GRE questions materially depend, such that further downstream elaboration would accumulate uncertainty faster than it generates independent discrimination.

Examples include inadequate relation typing, unstable value categories, unknown manifestation mappings, ambiguous conversion interfaces, or an unvalidated historical bridge. Identifying these bottlenecks can prevent a large research programme from becoming formally elaborate while resting on one weak empirical or conceptual hinge.

Proposition 24.585 (Dependency-sensitive research priority). *GRE should assign elevated research priority to unresolved problems that combine high downstream dependency with feasible discriminating evidence, while preserving exploratory work where foundational questions are not yet empirically tractable.*

This creates room for a balanced portfolio. Some studies should test central concepts directly. Some should develop better observations or archives. Some should explore domains in which a concept is likely to fail. Others should build new formal representations only after the relevant semantics are sufficiently stable. Programme coherence arises from explicit dependencies rather than uniform method or topic.

24.23.3 Collaboration Architecture for Unresolved Problems

Many GRE limits are not problems that economics can resolve internally. Legal status, ecological process, educational quality, technical capability, historical category meaning, political legitimacy, aesthetic judgment, and other predicates may be economically consequential while requiring external expertise and warrant. Chapter 23 established the importance of receiving-domain correction. Chapter 24 adds a further reason for collaboration: some GRE questions are underdetermined precisely because their evidence and concepts are distributed across domains.

Definition 24.586 (GRE collaboration interface). A *GRE collaboration interface* specifies the shared research object, the predicates assigned to each participating domain, evidence contributed by each domain, translation assumptions, unresolved semantic differences, decision rights over domain-specific claims, correction pathways, and the GRE conclusions that depend on the collaboration.

Collaboration should therefore not be organized as economics importing facts after the substantive problem has already been defined. A legal scholar may show that the economic object was misclassified because the relevant right is not transferable. An ecologist may show that a proposed value-conversion account mistakes compensation for restoration. An educator may show that a measured capability proxy does not establish learning. A historian may show that the category used in the analysis did not exist in the relevant period. An AI researcher may show that a supposed capability difference depends on a rapidly obsolete model configuration.

Definition 24.587 (Epistemic division of labour). An *epistemic division of labour* is a collaboration arrangement in which different investigators or domains carry differentiated responsibility for specified evidential, semantic, historical, technical, or normative components of a shared claim while the dependencies among those components remain explicit.

Division of labour should not imply fragmentation. The interface problem itself may require joint reconstruction because the economic consequence is produced by the coupling among legal rules, organizational practices, technical systems, ecological processes, or cultural meanings. In those cases the relation among domains becomes part of the research object.

Definition 24.588 (Collaboration correction protocol). A *collaboration correction protocol* states how a revision in one participating domain's warranted premise propagates into the joint analysis, which dependent GRE claims require re-evaluation, and which claims remain unaffected.

The protocol makes collaboration durable across theoretical change. It also reduces the risk that GRE preserves an imported premise after the source discipline has revised or rejected it. Collaboration thus becomes part of the programme's error-correction architecture rather than a source of disciplinary breadth alone.

Proposition 24.589 (Distributed-warrant collaboration principle). *When a GRE claim materially depends on premises whose strongest warrant lies in neighboring domains, the research design should distribute evidential and correction authority accordingly rather than translating those premises into economic vocabulary and treating them as internally established.*

24.23.4 Defeat-Test Design

Sections 24.20–24.22 made failure modes, counterevidence, and major-revision conditions explicit. The open programme should therefore include studies designed not merely to demonstrate GRE concepts but to expose their defeat conditions. Such studies are especially important for flexible concepts such as relation, generation, value, power, field, manifestation, or participation, where confirmatory interpretation can otherwise expand with the evidence.

Definition 24.590 (GRE defeat-test protocol). A *GRE defeat-test protocol* specifies the claim under test, its operative scope, serious rival explanations, expected observations under the GRE claim and its rivals, relevant negative evidence, measurement and representation limits, local defeat conditions, escalation conditions, and the revision action to be taken if the defeat condition is met.

The protocol need not resemble one experimental falsification template. Historical counterexample research, comparative institutional analysis, mechanism tracing, replication, robustness analysis, formal equivalence tests, failed domain transfer, archival disconfirmation, and rival-theory comparison can all provide defeat-relevant evidence. What matters is that the design could rationally lower the status of the claim rather than only enrich its interpretation.

Definition 24.591 (Adversarial GRE study). An *adversarial GRE study* is a study deliberately structured to identify conditions under which a GRE explanation loses discrimination relative to a serious alternative, including conditions selected because they are expected to stress the concept rather than display it favorably.

Adversarial study design is particularly useful for cross-domain portability and historical generalization. Cases should not be selected only where relational or generative vocabulary already appears intuitively suitable. Ecological systems with strongly material constraints, legal systems with constitutive status rules, markets with near-complete commensuration, or historical episodes poorly captured by generative narratives may provide more informative stress tests than paradigmatic examples.

Definition 24.592 (Negative-result preservation record). A *negative-result preservation record* stores failed identification, non-replication, unsuccessful transfer, null mechanism evidence, incompatible formalization, adverse historical cases, and abandoned conceptual distinctions together with the scope and assumptions under which the negative result was obtained.

Negative-result preservation matters because an open programme can otherwise accumulate positive examples while repeatedly forgetting where concepts failed. The record should remain part of theoretical provenance, especially when later versions of GRE modify the relevant concept.

Proposition 24.593 (Defeat-test inclusion principle). A *mature GRE research direction* should include at least one credible design capable of lowering the warranted status of its central claim; a programme composed only of illustrative, confirmatory, or vocabulary-expanding studies is insufficiently answerable to counterevidence.

This principle does not require every individual study to be adversarial. It requires the portfolio to contain serious opportunities for defeat and revision.

24.23.5 Domain-Interface Research

Domain interfaces are not completed once a translation vocabulary has been written. They are empirical and conceptual research sites. Each interface should ask which economic claims survive receiving-domain reconstruction, which concepts change type, which imported premises remain externally warranted, which remainders resist translation, and whether the interface reveals a limitation in GRE rather than only a difference between disciplines.

Definition 24.594 (Domain-interface research agenda). A *domain-interface research agenda* is a set of paired or multi-domain inquiries designed to test translation, non-translation, reciprocal correction, constitution across domains, and the stability of GRE claims after receiving-domain reconstruction.

The agenda should include successful and failed interfaces. A successful transfer may show that a GRE distinction has wider analytical value. A failed transfer can reveal which assumptions are specifically economic. A partially successful transfer may identify a thinner shared structure plus a substantial domain-specific remainder. None of these outcomes alone establishes a general GRT structure.

Definition 24.595 (Interface stress case). An *interface stress case* is a research case selected because economic and neighboring-domain constitutions are difficult to separate, translation loss is expected to be substantial, or competing domains assign materially different meanings or authorities to apparently shared concepts.

Examples include property relations whose legal constitution changes economic control, ecological restoration projects in which compensation and ecological regeneration diverge, educational technologies whose measured productivity and educational quality diverge, or AI-mediated institutions in which technical capability, legal responsibility, organizational authority, and economic dependence evolve at different rates. Such cases are valuable because they test whether predicate-specific jurisdiction and domain containment continue to constrain inference.

Proposition 24.596 (Interface correction-loop principle). *Domain-interface research should be designed as a correction loop in which GRE generates questions for neighboring domains, receiving-domain findings can alter GRE premises, and the revised GRE account is re-tested for economic consequence without treating either direction of translation as authoritative by default.*

The principle gives cross-domain openness an operational form. It also creates comparative material for future generalization without making cross-domain similarity a premise of the research.

24.23.6 Historical Revalidation Discipline

A research programme situated in historical time cannot assume that its concepts, measurements, institutional referents, or empirical regularities retain fixed meaning. Historical revisability applies both backward and forward. Earlier periods may require reconstructed categories that differ from present GRE terms, while future economic systems may generate new relations, value forms, AI configurations, institutional structures, or ecological constraints for which present concepts are inadequate.

Definition 24.597 (Historical revalidation task). A *historical revalidation task* examines whether a GRE claim retains its meaning, mechanism, evidential bridge, and

scope when transported across a materially different historical configuration, including changed institutions, categories, technologies, ecological conditions, value forms, or manifestation regimes.

Historical revalidation differs from replication. Replication may ask whether an empirical pattern recurs under comparable conditions. Historical revalidation asks whether the object and inferential bridge remain sufficiently stable for the claim to be the same claim. A category can retain its name while changing constitution; an apparently stable institution can acquire different functions; a power mechanism can migrate from direct control to infrastructural dependence; a value form can be reclassified or generated through new technical systems.

Definition 24.598 (GRE validity horizon). A *GRE validity horizon* is the declared historical and institutional range within which a claim is presently expected to retain sufficiently stable semantics, mechanism, and evidential support without renewed reconstruction.

Validity horizons can differ sharply by claim. A basic distinction between transfer and generation may have a long conceptual horizon while a claim about one AI capability stack may require rapid revalidation. A historical category may be meaningful only for a narrow institutional period. A justice claim may depend on a normative premise whose authority is explicitly contested. The horizon should therefore be attached to the claim rather than to GRE as a whole.

Definition 24.599 (Theory-expiration trigger). A *theory-expiration trigger* is a materially relevant change in the configuration on which a GRE claim depends that requires revalidation before the claim is transported further, even when no direct counterexample has yet been observed.

Triggers can include institutional redesign, category change, technological discontinuity, ecological regime change, changed data-generation processes, new legal constitution, altered human–AI division of labour, or evidence that the original manifestation relation no longer holds.

Proposition 24.600 (Historical revalidation principle). *GRE should treat transport across material historical change as a new inferential task rather than as automatic continuation of an earlier result; where a validity horizon has been crossed, revalidation should precede strong claims of persistence or generality.*

Historical revalidation also preserves theoretical memory. When a claim expires or changes type, the earlier version should remain reconstructable rather than silently rewritten in current vocabulary. This allows the history of GRE itself to become evidence about how theory changes with its objects.

24.23.7 Future-Theory Formation

An open programme should permit new theory to arise from unresolved problems without treating every recurring pattern as a new foundational layer. Future theory can emerge through repeated empirical regularities, failed transfers, unresolved remainders, new formal distinctions, newly observable mechanisms, or persistent anomalies in the present architecture. The evidential threshold should rise with the scope of the proposed theory.

Definition 24.601 (Future-theory candidate). A *future-theory candidate* is a proposed concept, mechanism, formal structure, or architectural revision generated by recur-

rent limitation-derived evidence and specified with its source problems, domain of support, rival formulations, non-supporting cases, evidential status, and expected consequences for existing GRE claims.

A candidate should not become part of GRE merely because it is elegant or integrates many terms. A new formalism may be useful only schematically. A recurring cross-domain pattern may arise from shared conceptual ancestry. A new value form may be a context-specific subtype rather than a general category. A new power mechanism may belong to a neighboring domain. The candidate stage therefore protects both innovation and restraint.

Definition 24.602 (Theory-promotion dossier). A *theory-promotion dossier* records the evidence required to move a future-theory candidate into a stronger programme status, including independent supporting cases, failed-case analysis, semantic stability, historical variation, empirical discrimination, formal necessity where relevant, domain corrections, and the claims that would change if the candidate were accepted.

Promotion need not be binary. A candidate can remain a heuristic, become a domain-specific hypothesis, become a structural formalization, acquire empirically parameterized support, or be incorporated as a revisable conceptual distinction. This preserves the claim-status discipline developed throughout the book.

Definition 24.603 (Theory retirement condition). A *theory retirement condition* is reached when a GRE concept or model repeatedly fails its declared discriminating tasks, is superseded by a clearer formulation, or no longer contributes enough explanatory, empirical, or practical value to justify maintaining it as active programme infrastructure.

Retirement is compatible with preservation. A retired concept can remain historically important, pedagogically useful, or locally adequate. The point is to avoid treating theoretical accumulation as one-way expansion.

Proposition 24.604 (Future-theory proportionality principle). *The evidential burden for a future GRE theory should increase with the breadth of the claim it reorganizes: local concepts can be supported locally, while claims that alter core vocabulary, architecture, domain boundaries, or candidate GRT structures require correspondingly broader independent comparison and counterevidence testing.*

This principle permits theoretical creativity while resisting premature unification. It also supplies a bridge to Chapter 25, which considers the programme identity capable of surviving plural formulations and future revision.

24.23.8 Integrated Limitation-Derived Programme

Chapter 24's limitation record can be synthesized as an architecture of dependencies among claims, tests, domains, histories, methods, and revision pathways. An open programme should distinguish what is established, provisional, outside present authority, or defeated, and should make visible how a change in one status propagates elsewhere.

Definition 24.605 (Integrated GRE limitation-derived programme). The *integrated GRE limitation-derived programme* is the coordinated portfolio of scope conditions, discriminating questions, research-direction packets, collaboration interfaces, defeat tests, negative-result records, domain-interface agendas, historical revalidation tasks, and future-theory dossiers attached to consequential GRE claim families.

Coordination matters because one finding can affect several layers. An archival source can revise a reconstruction and thereby change a conversion claim; a legal reinterpretation can retype an institution and alter a power analysis; a failed replication can weaken one mechanism without defeating the broader distinction. The programme should therefore represent dependencies rather than count findings as independent units.

Definition 24.606 (GRE programme dependency map). A *GRE programme dependency map* records which claims depend on which conceptual distinctions, external premises, empirical identifications, historical bridges, value classifications, formal representations, and normative commitments, together with the revision pathways activated when one dependency changes status.

The map supports selective revision: local counterevidence need not become total framework failure, while a foundational defeat should not be isolated artificially when many downstream claims depend on it. The surrounding research portfolio should also include constructive, comparative, adversarial, replication, historical, formal, cross-domain, negative-result, and revision-oriented work so that one method or evidential direction does not become self-reinforcing.

Proposition 24.607 (Scope-conditioned research principle). *Every consequential GRE extension should carry an explicit scope discipline stating what the study seeks to establish, what it does not establish, what could defeat or revise it, which external warrants it depends on, and how a sustained result would alter the programme.*

Scope conditions are therefore part of research design rather than barriers added afterward. They help distinguish discovery from semantic expansion, successful transfer from domain overreach, formal insight from ontological escalation, and practical usefulness from normative authority.

Definition 24.608 (Constructive incompleteness). *Constructive incompleteness* is a programme condition in which unresolved questions, non-claims, failed transfers, negative results, rival theories, and known limits remain explicit resources for inquiry rather than being concealed by premature closure.

Constructive incompleteness is constrained by the defeat and revision disciplines of Sections 24.21 and 24.22. Openness without defeat conditions becomes insulation; defeat conditions without openness can freeze the programme around present formulations.

Proposition 24.609 (Chapter 24 open-limit principle). *Present GRE limits should function simultaneously as boundaries on current claims and as structured invitations to research: a limitation may justify a non-claim, generate a discriminating question, organize collaboration, specify counterevidence, and later become a site of conceptual or architectural revision.*

Chapter 24 therefore closes with a bounded claim. GRE becomes more answerable when its limits are typed, failures preserved, counterevidence propagated, and future extensions conditioned on renewed evidence and domain correction. Chapter 25 can now ask the wider closing question: what kind of open programme can remain recognizably GRE while permitting plural formulations, contestation, historical re-epistemization, and revision of the concepts through which the programme presently understands itself?

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Chapter 25

Generative Relational Economics as an Open Research Programme

Programme Identity and Provisional Closure

Chapter 25 provides the book-level disciplinary return for Generative Relational Economics (GRE). The preceding chapters have constructed historical motivations, preliminary generative-relational foundations, research and applied praxis, substantive economic concepts, theoretical dialogues, cross-domain interfaces, and an explicit architecture of limitations and revision. The final chapter does not add another substantive domain on top of that sequence. Its role is to determine what kind of scholarly object has emerged from it: which parts of the framework presently function as substantive claims, which remain proposals or hypotheses, which operate as heuristics or representations, which commitments hold the programme together, and which forms of disagreement and revision can occur without making the programme unintelligible.

The chapter therefore treats closure as a problem of *programme identity under revisability*. A research programme can become too closed when its vocabulary, methods, or foundational distinctions are protected from counterevidence. It can also become too indeterminate when almost any later formulation can be redescribed as belonging to the same programme. GRE requires a middle discipline. It should remain sufficiently specified that researchers can identify what counts as a GRE claim, compare competing formulations, test consequences, preserve negative results, and recognize major revision. At the same time, its identity should not depend on freezing one ontology, one formalism, one value theory, one method, or one historically situated vocabulary.

The immediate task is consequently synthetic and reconstructive. Chapter 25 asks what the book has actually constructed, what epistemic status should be assigned to its different components, which commitments presently define GRE, and which apparent commitments are explicitly withheld. It then examines GRE as a language of economic inquiry and as an economic-domain instantiation of broader generative-

relational foundations. The chapter subsequently considers historical revisability, plural internal formulations, collaboration and contestability, preservation and provenance, future re-epistemization, and openness to evidence from economics and neighboring domains.

The final part of the chapter turns to theoretical evolution and economic futures. GRE does not presume that cumulative research will converge upon one immutable formulation or one predetermined economic order. Accumulation, critique, revision, branching, hybridization, abandonment, and later re-emergence can all belong to the history of a research programme. Correspondingly, economic futures remain objects of inquiry and praxis rather than endpoints already encoded in the theory. The chapter therefore closes by stating what GRE asks researchers and practitioners to notice, what problems remain explicitly unfinished, and what provisional closure means for a programme whose own future transformation is part of its stated architecture.

The method throughout is dependency-sensitive rather than celebratory. A concluding synthesis is useful only if it preserves the distinctions and limitations established earlier in the book. Chapter 25 therefore avoids converting recurring vocabulary into universal truth, formal representations into ontology, generativity into normative priority, or the completion of a first draft into completion of the research programme. The final question is narrower and more demanding: whether the framework constructed in this book is coherent enough to support cumulative inquiry and open enough to remain answerable to evidence, criticism, domain correction, historical change, and later theoretical reconstruction.

The chapter proceeds in nineteen sections. Section 569 reconstructs the book-level GRE architecture. Sections 570–572 clarify the epistemic status, commitments, and non-commitments of the present framework. Sections 573–581 examine GRE as a language and domain instantiation, its historical revisability, plural formulations, contestability, provenance, future re-epistemization, domain evidence, and cross-domain learning. Sections 582–583 address theoretical evolution and open economic futures. Sections 584–585 state the attentional disciplines proposed for research and practice. Section 586 records work deliberately left unfinished. Section 587 then provides a provisional closure whose purpose is to make continuation, criticism, and revision possible without dissolving the identity of the programme.

25.1 Book-Level Architecture of GRE

The opening section of Chapter 25 reconstructs the architecture assembled across the book and clarifies how its major components depend upon one another. Its role is synthetic rather than retrospective: the objective is not to provide a compressed chapter-by-chapter synopsis, but to identify the intellectual functions that the manuscript has constructed and the interfaces through which they form a recognizable Generative Relational Economics (GRE) research programme. The discussion proceeds through historical emergence, intellectual foundations, disciplinary constitution, ontology, epistemology, research praxis, applied praxis, substantive economic theory, theoretical dialogue, and programme formation. The method is dependency-sensitive reconstruction. Each component is treated according to what analytical work it performs, what other components it presupposes, and what would be lost if it were removed or collapsed into a neighboring component.

Definition 25.1 (Book-level GRE architecture). The *book-level GRE architecture* is the dependency-organized configuration of historical motivations, disciplinary commitments, ontological and epistemic restraints, research and applied praxis, substantive economic concepts, dialogue mechanisms, domain interfaces, limitation disciplines, and revision procedures constructed across the manuscript.

This definition treats the book's contribution as more than an inventory of concepts. Relational allocation, generative value, conversion, circulation, economic spacetime, power, justice, epistemic economy, and AI-era capability asymmetry receive their meaning partly from the ontological, epistemological, historical, and methodological disciplines within which they are used. Likewise, the open research programme of the final Part depends on substantive objects capable of being tested, translated, narrowed, or abandoned. The architecture is therefore layered without being a simple hierarchy: later components can correct earlier ones, while earlier distinctions constrain the meanings available to later claims.

Table 25.1 summarizes the principal functions reconstructed in this section. The table is intentionally functional rather than chronological. Several functions were developed across multiple chapters, and the mature architecture sometimes revises the terms in which an earlier problem was first posed.

Proposition 25.2 (Architecture-over-inventory principle). *The book-level contribution of GRE is better evaluated through the relations among its historical, conceptual, methodological, substantive, and revision components than through the novelty or completeness of any isolated term.*

The proposition does not imply that every component is equally mature. Some distinctions have been developed extensively; others remain proposals, heuristics, or open research problems. The point is structural. A value-conversion concept without an epistemology of identification can become metaphorical. A power concept without typed asymmetry and mechanism evidence can become indiscriminate. A relational ontology without manifestation and representation limits can outrun evidence. An open programme without failure conditions can become self-insulating. The architecture attempts to place these problems in a mutually corrective configuration.

25.1.1 Historical Emergence

The book begins by treating GRE as historically situated rather than as a timeless theory waiting to be discovered. Contemporary economic life combines large-scale institutional interdependence, digital and computational mediation, changing forms of scarcity, globally extended production and exchange, intensified representational infrastructures, ecological constraint, and rapidly changing human–AI capability relations. These conditions do not logically entail GRE. They establish a problem environment in which entity-centred, static, or exclusively allocation-centred descriptions can leave consequential questions insufficiently articulated.

The historical construction is therefore motivational and restrictive at the same time. It motivates attention to relations, generation, conversion, circulation, capability formation, institutional mediation, delayed effects, and transformed option spaces. It also restricts GRE from presenting categories formed under contemporary conditions as universal economic primitives. A concept that is analytically useful for platform-mediated production, AI-assisted knowledge work, credentialized institutions, or contemporary monetary infrastructures may require substantial

Table 25.1: Principal components of the book-level GRE architecture and their analytical roles

Component	Principal analytical role	Dependency or corrective relation
Historical emergence	Locates the problems that make GRE intelligible as a contemporary economic inquiry	Constrains claims of universality and supplies historically changing problem conditions
Intellectual foundations	Provides relational, generative, institutional, historical, value-theoretical, and methodological resources	Supplies resources without making any inherited tradition canonical
Disciplinary constitution	Specifies GRE's economic problem-space, objects, questions, and contribution standards	Prevents domain expansion from being mistaken for general theory
Ontology and epistemology	Disciplines claims about relational reality, manifestation, representation, and warranted reconstruction	Constrains substantive and formal claims while preserving ontological suspension
Research praxis	Organizes inquiry under partial observation, plural methods, and generative-relational questions	Converts conceptual distinctions into answerable research designs
Applied praxis	Organizes decision and intervention under incomplete knowledge, value conflict, and practical consequence	Requires monitoring, participation, reversibility, learning, and responsibility
Substantive economic theory	Develops relational architecture, allocation, value, space-time, power, knowledge, AI, and economic-order problems	Gives GRE domain-specific explanatory content that can be empirically and normatively contested
Theoretical and domain dialogue	Enables translation, comparison, borrowing, correction, and non-translation	Prevents isolation while preserving theoretical and disciplinary non-equivalence
Limits and revision architecture	States uncertainty, failure conditions, defeat, and architectural revision thresholds	Makes substantive claims corrigible rather than semantically self-protective
Open research programme	Coordinates questions, dependencies, evidence, negative results, collaboration, and future theory	Preserves cumulative inquiry without treating the present framework as final

reconstruction in another historical configuration.

Definition 25.3 (Historical problem field of GRE). The *historical problem field of GRE* is the historically situated configuration of economic changes, institutional forms, technical capabilities, value conflicts, and representational conditions that makes particular generative-relational questions salient without establishing those questions as transhistorical necessities.

The mature GRE architecture consequently preserves historical emergence inside later theory. Historical situatedness is not confined to an introductory genealogy. It

returns in category revision, multiple timescales, institutional transformation, power continuity, domain transfer, AI-era validity horizons, and the requirement that theory itself remain historically revisable.

25.1.2 Intellectual Foundations

GRE was not constructed from a single intellectual lineage. The manuscript instead develops a plural inheritance from relational, processual, institutional, historical, evolutionary, value-theoretical, complexity-sensitive, capability-oriented, political-economic, and methodological traditions. These inheritances supply questions and analytical resources rather than a synthetic canon. Their disagreements remain important because GRE's own distinctions often arise precisely where existing approaches illuminate different aspects of the same economic process.

The foundational strategy is therefore one of critical inheritance. Concepts are retained when they clarify the economic problem under examination, retyped when their source-domain semantics do not transfer directly, and left unresolved when translation would erase a substantive disagreement. This strategy also applies to mathematical resources. Networks, dynamical systems, higher-order structures, fields, operator-like representations, category-theoretic language, 2-complexes, and related formalisms can provide useful structural representations, but their presence in GRE does not import the ontologies or empirical meanings of the domains from which the mathematics originated.

The most important intellectual construction is accordingly a discipline of combination. GRE permits multiple theoretical resources to participate in one research problem while resisting the inference that successful coexistence proves their theoretical identity. Chapter 21 later makes that discipline explicit through relational dialogue among economic theories, while Chapters 23–24 extend it to neighboring domains, failed translations, and the limits of generalization.

25.1.3 Disciplinary Constitution

The book constructs GRE as an economic research programme with a distinct but revisable problem-space. Its disciplinary constitution does not depend on a unique class of empirical objects. Families, firms, schools, courts, platforms, infrastructures, ecosystems, AI systems, and public institutions can all become economically relevant without becoming exclusively economic objects. GRE's domain is specified more usefully through the predicates and mechanisms for which economic explanation is being undertaken.

GRE asks, among other questions, how resources, relations, institutions, classifications, infrastructures, and interventions alter capacities, option spaces, patterns of participation, value realization, conversion possibilities, circulation paths, dependencies, and later conditions of generation. It also asks how apparently given economic subjects and categories become stabilized, how asymmetries become consequential power, how values remain heterogeneous or become institutionally commensurated, and how current economic activity changes the conditions of future economic activity.

Definition 25.4 (GRE disciplinary constitution). The *disciplinary constitution of GRE* is the provisional specification of an economic problem-space, explanatory respon-

sibilities, research questions, contribution standards, and interfaces through which generative-relational analysis becomes recognizably economic while remaining open to correction by neighboring domains.

This constitution is intentionally non-imperial. Economic incidence does not confer authority over legal validity, political legitimacy, ecological value, educational quality, aesthetic judgment, technical capability, consciousness, or ultimate ontology. Chapter 23 develops this boundary through predicate-specific jurisdiction and domain deference. Chapter 24 makes the boundary revisable when repeated interface problems show that the current division of explanatory labour is inadequate.

25.1.4 Ontological View

The ontological construction of the book is deliberately restrained. The preliminary GR foundations required by GRE begin from sparse analytical primitives—change, structure, constraint, and difference—and develop richer relational objects without claiming that these primitives or their formal representations exhaust ultimate reality. The three-level distinction among ontological reality, relational reality, and manifestational reality provides the principal discipline.

Ontological reality remains suspended where the inquiry lacks warrant for stronger metaphysical claims. Relational reality concerns sufficiently stable, historically sustained, and causally consequential relational configurations that can participate in economic explanation. Manifestational reality concerns the context-dependent forms through which such configurations become accessible. The distinction permits GRE to treat institutions, currencies, identities, classifications, AI-mediated roles, legal-economic positions, and other relational beings as causally significant without converting their current manifestation into a claim about final ontology.

The mature ontology is therefore bounded relationally rather than relationally exhaustive. Relations receive methodological and often explanatory priority because many economic objects are constituted or transformed through relations. Chapter 24 nevertheless requires mixed explanatory architectures when material, technical, biological, ecological, legal, phenomenological, or other mechanisms add independent discrimination. Relational language is useful to the extent that it clarifies rather than absorbs those differences.

25.1.5 Epistemology

GRE's epistemology follows from the gap between relational reality and the manifestations through which inquiry proceeds. Economic research ordinarily encounters records, prices, classifications, measurements, documents, narratives, institutional categories, model outputs, observed interactions, and other representations. These are neither transparent copies of relational reality nor epistemically useless surfaces. They are historically generated access conditions whose production and limitations require analysis.

The book therefore constructs inquiry as an inverse and often underdetermined problem. Several relational histories can produce similar manifestations; one classification can suppress materially important differences; observation can alter the system observed; missingness can be relationally patterned; and later categories can

distort reconstruction of earlier economic worlds. The appropriate response is not generalized skepticism. It is bounded reconstruction through explicit assumptions, rival explanations, compatibility classes, sensitivity analysis, negative evidence, and preservation of epistemic remainders.

This epistemology also constrains formalization. A symbol can be mathematically exact while the bridge connecting it to an empirical target remains uncertain. Formal determinacy should therefore remain no stronger than the semantic and evidential warrant supporting the represented object. The book's formal resources are most defensible when their inferential role is stated locally and their projection losses remain visible.

25.1.6 Research Praxis

The research-praxis block converts ontological and epistemological discipline into procedures for inquiry. Research-dominant praxis is organized around a principal contradiction between the need to know enough to make a warranted scholarly claim and the incompleteness, historical situatedness, and intervention effects of actual inquiry. Relational and generative-relational methodologies address that contradiction through explicit problem formulation, boundary construction, relation identification, historical reconstruction, mixed evidence, model comparison, and iterative revision.

The distinctive research question is not simply whether variables covary or whether an entity possesses a property. GRE asks what is generated, through which relations and conditions, for which positions, over which horizon, with which conversions and circulation paths, and with which foreclosures or residual effects. Such questions can be pursued historically, interpretively, qualitatively, quantitatively, empirically, formally, or computationally. Methodological pluralism follows from the heterogeneity of access conditions rather than from a refusal to discriminate among methods. A method earns priority when it is better suited to the local question and evidential task.

The integrated research-design architecture constructed in Part III links problem formation, evidence, historical context, relation typing, generative attribution, formal representation, triangulation, uncertainty, and revision. Later chapters add explicit identification ladders, negative-result preservation, defeat tests, and validity horizons. Research praxis thus becomes one of the mechanisms through which GRE remains open without becoming epistemically permissive.

25.1.7 Applied Praxis

Application-dominant praxis addresses a different principal contradiction: decisions and interventions must often occur before the relevant economic system is completely known. The book therefore refuses to make complete prediction a prerequisite for responsible action while also refusing to convert urgency into evidential certainty. Applied GRE emphasizes intervention adequacy under incomplete knowledge.

The constructed methodology includes relational consequence analysis, long-horizon attention, reversibility, option preservation, participation, value conflict, power asymmetry, monitoring, institutional capacity, repair, and learning through action. Interventions are treated as transformations that can alter the evidence

environment, the subjects involved, the relations among them, and the possibility space in which later decisions occur. The distinction between observation and transformation is therefore preserved even when actual praxis couples them tightly.

Applied praxis also treats inaction symmetrically. Waiting, continuation of an inherited policy, refusal to intervene, or withdrawal can redistribute risk and close future options just as active intervention can. The relevant comparison concerns alternative courses of action under bounded knowledge, not an opposition between risky action and neutral non-action.

25.1.8 Substantive Economic Theory

The book's substantive economic construction begins with relational architecture and proceeds through allocation, heterogeneous generative value, generative spacetime, power and justice, epistemic economy, AI-era capability asymmetry, domain applications, and possible economic orders. These components supply GRE with economic content that exceeds a general preference for relational language.

Relational architecture treats economic systems as historically generated configurations of subjects, institutions, resources, rules, classifications, infrastructures, and relations whose boundaries and memberships can themselves change. Allocation is reconstructed as relational intervention because allocating resources can alter more than the nominal recipient: it can reorganize enabling conditions, dependencies, future capacities, and higher-order relations. Generative value then asks how heterogeneous value forms arise, convert, circulate, return, dissipate, become captured, or contribute to later generation without presuming a universal metric.

Generative spacetime provides a representation of history-bearing economic configurations in which past structure conditions present possibilities and present transformations alter future relational possibilities. It permits 2-complex, field-like, dynamical, and operator-like representations where useful, while Chapter 24 explicitly prevents any one such formalism from becoming mandatory or ontologically privileged.

The later substantive chapters add typed asymmetry and power, justice under heterogeneous value, knowledge and epistemic economy, and human–AI capability relations. Power is reconstructed through directional mechanisms that condition another position's possibilities; justice requires an independent normative bridge; epistemic resources and infrastructures become economically consequential without knowledge being reduced to a scalar asset; and AI is treated as a relational configuration whose economic effects depend on access, verification, organization, infrastructure, and institutional mediation.

The substantive synthesis is therefore plural. GRE does not culminate in one equilibrium state, welfare function, or ideal institutional form. It offers a family of typed questions and mechanisms for studying how economic configurations produce, distribute, preserve, convert, foreclose, and transform the conditions of later economic life.

25.1.9 Theoretical Dialogue

GRE is constructed in dialogue with existing economic theories rather than as their replacement. The book develops relational translation as a way to compare units of

analysis, subjects, relations, value, scarcity, time, institutions, knowledge, power, and causal explanation across theoretical traditions. Translation can reveal correspondence, complementary explanatory reach, and hidden assumptions. It can also fail, and those failures are theoretically informative.

The mature dialogue architecture distinguishes translation from identity and comparison from commensuration. A neoclassical, institutional, evolutionary, capability-oriented, feminist, ecological, Marxian, Keynesian, behavioural, or other economic analysis can illuminate a problem without being reducible to GRE vocabulary. Equivalence is claim-relative and task-relative. Irreducible disagreement remains part of the comparative object.

The same discipline governs neighboring domains. History, governance, law, political theory, education, ecology, AI studies, social theory, and aesthetics can provide premises that correct GRE while retaining authority over their own predicates. GRE can also offer candidate structures outward, but successful borrowing remains weaker evidence than independently rediscovered recurrence. This architecture creates cross-domain learning while withholding premature general GRT.

25.1.10 Research Programme

The final construction is the research programme itself. Chapters 22–24 progressively make explicit what was implicit in earlier substantive work: GRE requires question portfolios, dependency maps, domain interfaces, research streams, scope conditions, validity horizons, negative-result preservation, failure conditions, revision pathways, and criteria for theory promotion or retirement. A research programme is therefore not simply a list of topics generated by a theory. It is an organized environment in which claims can accumulate, diverge, fail, and be reconstructed while their evidential and conceptual histories remain recoverable.

Definition 25.5 (Constructed GRE programme state). *The constructed GRE programme state* is the present, versioned configuration of GRE claims, proposals, hypotheses, heuristics, representations, empirical questions, domain interfaces, limitations, counterevidence pathways, and revision dependencies established by the book at a particular historical point.

The definition deliberately uses *state*. The completed manuscript does not convert GRE into a finished system. It records a sufficiently articulated configuration from which future work can proceed and against which future revisions can be understood. Some components may strengthen through empirical replication; some may split into competing formulations; some may be localized to particular historical or institutional regimes; some may become unnecessary when better concepts are developed; and some may be abandoned.

Proposition 25.6 (Constructed-programme principle). *The principal scholarly object constructed by the book is a domain-specific, historically situated, empirically answerable, normatively non-self-authorizing, and revisable programme for generative-relational economic inquiry whose identity is carried by a structured set of questions, distinctions, dependencies, and correction procedures rather than by an immutable vocabulary or single formal system.*

This proposition supplies the starting point for the remainder of Chapter 25. Before the programme's identity can be stated more precisely, the different components of the present framework require explicit epistemic typing. A proposition argued sub-

stantively in one chapter, a methodological proposal, a testable hypothesis, a heuristic distinction, a formal representation, a domain-specific empirical result, and an unresolved open problem should not enter the final synthesis with the same status. Section 570 therefore turns from the architecture constructed by the book to the status of the claims that presently compose it.

25.2 Epistemic Status of the Present Framework

Section 25.1 reconstructed GRE as a dependency-organized research architecture whose components have been developed through different modes of argument, evidence, formalization, and disciplinary interaction. The role of the present section is to prevent the final synthesis from flattening those differences into a single level of theoretical authority. Its objective is to assign explicit epistemic status to the principal kinds of objects carried by the present framework, to state what each status licenses, and to identify how components may be promoted, narrowed, revised, or retired as later inquiry develops. The method is classificatory and dependency-sensitive. A component is typed according to the role it presently performs in the programme rather than according to its rhetorical importance or the amount of notation surrounding it.

The resulting classification is intentionally plural. GRE presently contains argued claims, conceptual and methodological proposals, testable hypotheses, heuristics, formal representations, domain-specific results, open problems, and unresolved disagreements. These statuses can interact, and the same substantive topic can contain objects of several types. A formal representation can support a hypothesis without becoming evidence for it; a proposal can organize research before empirical results exist; a domain-specific result can motivate a broader hypothesis without establishing cross-domain generality; and an unresolved disagreement can remain productive without being redescribed as theoretical incoherence.

Definition 25.7 (GRE epistemic-status profile). A *GRE epistemic-status profile* records, for a specified programme component, its current status as claim, proposal, hypothesis, heuristic, formal representation, domain-specific result, open problem, unresolved disagreement, or a locally justified combination of these; the warrant supporting that status; the domain and historical scope of the warrant; dependencies on other claims or external premises; serious alternatives or counterevidence; and the conditions under which the status should be promoted, narrowed, revised, or retired.

The profile provides a book-level continuation of the limitation, defeat, and revision architecture developed in Chapter 24. Its function is constructive rather than merely cautionary. Explicit typing makes cumulative work easier because later researchers can determine whether new evidence is testing an empirical hypothesis, evaluating a conceptual proposal, comparing representations, refining a heuristic, or adjudicating a substantive disagreement. It also prevents an apparent contradiction created by assigning different epistemic burdens to objects that perform different scholarly functions.

Table 25.2 summarizes the principal statuses used in this chapter. The categories are neither a ranking of intellectual importance nor a linear maturation sequence. Some proposals may remain proposals because their value lies in organizing inquiry rather than becoming truth-apt empirical statements. Some heuristics may remain

Table 25.2: Epistemic statuses within the present GRE framework.

Status	Present function	Principal discipline
Claim	States an argued conclusion within a declared conceptual, historical, empirical, or normative scope	Preserve warrant, scope, dependencies, and defeat conditions
Proposal	Offers a concept, distinction, method, procedure, or research architecture for use and evaluation	Assess analytical usefulness, coherence, alternatives, and downstream consequences
Hypothesis	Makes a provisional, contrastable claim about a mechanism, relation, pattern, or condition	Specify discriminating evidence, serious rivals, and conditions of weakening or rejection
Heuristic	Directs attention or organizes inquiry without claiming complete description or mechanism identification	Evaluate discovery value, bias, omissions, and the point at which stronger claims require independent warrant
Formal representation	Encodes selected structure through mathematical, diagrammatic, computational, or logical form	Define semantics, assumptions, projection loss, empirical bridge, and non-ontological remainder
Domain-specific result	Establishes a finding within a specified economic, historical, institutional, or neighboring-domain context	Retain domain provenance, transport conditions, and correction authority
Open problem	Identifies an unresolved question whose answer can materially alter explanation, method, application, or programme architecture	Preserve tractability, dependencies, competing approaches, and research consequences
Unresolved disagreement	Records competing serious interpretations, models, normative premises, or programme formulations	Preserve the locus of disagreement, shared evidence, discriminating questions, and conditions for continued pluralism

useful even after specific hypotheses generated from them are rejected. Some formal representations may be replaced without altering the underlying substantive claim. Conversely, a hypothesis supported repeatedly within a stable domain may become a domain-specific result without thereby becoming a universal commitment of GRE.

Proposition 25.8 (Epistemic non-flattening principle). *A book-level synthesis of GRE should preserve the strongest epistemic distinctions that materially affect what a component licenses, how it can be tested, and what kind of revision follows from counterevidence; completion of the manuscript does not by itself raise proposals, hypotheses, heuristics, or representations to the status of established claims.*

The remainder of the section applies this principle to the eight status families that presently compose the programme.

25.2.1 Claims

A *claim* in the present framework is a proposition that the book argues should presently be accepted within a stated scope. Claim status remains compatible with revisability. The relevant question is whether the available conceptual argument, historical reconstruction, empirical evidence, domain warrant, or normative reasoning is strong enough for the particular conclusion being stated. Claim status therefore concerns warranted assertion within the present programme state rather than certainty beyond revision.

Several book-level claims have this character. The manuscript argues that economic phenomena can be constituted through historically generated relations; that observation and intervention should remain analytically distinguishable even when praxis couples them; that heterogeneous value cannot be assumed to share one common measure; that generativity and normative desirability require separate warrants; that economic power claims require typed asymmetry together with an identifiable conditioning mechanism; and that cross-domain translation does not establish theoretical identity. These conclusions are not all supported by the same kind of evidence. Some are conceptual distinctions required for inferential hygiene, some synthesize historical and theoretical argument, and some state programme-level methodological disciplines.

Definition 25.9 (Scoped GRE claim). A *scoped GRE claim* is an argued conclusion whose object, domain, historical or institutional conditions, evidential or conceptual warrant, dependencies, and relevant defeat conditions are sufficiently specified to determine what accepting the claim presently licenses.

This definition prevents the word *claim* from functioning as a synonym for settled fact. A conceptual claim can be well argued without being an empirical finding. An empirical claim can be strong within one institutional regime while remaining weakly transportable elsewhere. A normative claim can be defensible under explicit premises without becoming uniquely mandatory across all serious normative frameworks.

Proposition 25.10 (Claim-strength matching principle). *The strength of a GRE claim should remain matched to the strongest warrant that bears directly on its stated object and scope; additional conceptual richness, mathematical structure, or programme centrality does not independently increase that warrant.*

The book therefore contains claims of different breadth. Their common status lies in argued assertibility, not in equal certainty, equal empirical maturity, or equal transportability.

25.2.2 Proposals

A substantial part of GRE presently consists of proposals. These include conceptual distinctions, methodological procedures, diagnostic profiles, research records, interface architectures, revision protocols, and candidate analytical vocabularies offered because they appear capable of organizing economic inquiry more precisely. Proposal status is especially appropriate where the book establishes coherence and analytical motivation but where comparative use across independent studies remains limited.

Examples include the proposed use of relational allocation as a way to study

effects extending beyond nominal recipients; value-conversion and circulation ledgers for heterogeneous value processes; dependency-sensitive research portfolios; provenance-preserving domain interfaces; limitation and defeat registers; and versioned theory-promotion or retirement dossiers. The book argues for the usefulness of these devices, but usefulness ultimately requires practice beyond the manuscript. Researchers may discover that some records are too demanding for particular settings, that two distinctions can be merged, or that a simpler alternative performs the same analytical function more effectively.

Definition 25.11 (GRE analytical proposal). A *GRE analytical proposal* is a concept, distinction, procedure, representational practice, or research architecture advanced for disciplined use and comparative evaluation without presuming that its present formulation is uniquely necessary or empirically established across domains.

Proposal evaluation therefore differs from hypothesis testing. A proposal can fail because it produces little discrimination, obscures relevant objects, requires unavailable information, duplicates a simpler device, creates excessive conceptual overhead, or systematically biases inquiry. Conversely, repeated successful use can justify broader adoption without converting the proposal into a metaphysical or universal commitment.

Proposition 25.12 (Proposal promotion condition). *Repeated analytical usefulness can strengthen a GRE proposal's programme standing when independent applications demonstrate clearer discrimination, recoverable assumptions, productive comparison, and manageable revision costs; such success supports adoption of the proposal without establishing universal necessity.*

25.2.3 Hypotheses

GRE hypotheses make provisional claims about mechanisms, relations, dynamics, or empirical regularities for which discriminating evidence remains necessary. Hypothesis status is crucial because several intellectually attractive ideas in the book would become overclaims if presented as established results. The language of criticality, fast-slow dynamics, attractors, field-like organization, AI-mediated capability asymmetry, conversion mechanisms, generative feedback, and historical persistence can generate testable research programmes, yet each requires evidence suited to its specific mechanism and scope.

Definition 25.13 (GRE research hypothesis). A *GRE research hypothesis* is a provisional proposition concerning an empirically or historically discriminable mechanism, relation, pattern, or condition for which the programme can state serious rival explanations and evidence that would raise, lower, or localize its warranted status.

The definition excludes formulations that can accommodate every possible observation by retrospective reinterpretation. A useful GRE hypothesis identifies a contrast. A criticality hypothesis should specify expectations that differ from ordinary instability, institutional breakdown, or exogenous shock. A conversion hypothesis should distinguish conversion from transfer, co-generation, reclassification, or common-cause change. A power hypothesis should identify a conditioning mechanism that separates power from persistent inequality or shared constraint. A generativity hypothesis should distinguish generation from revelation of already existing capacity.

Proposition 25.14 (Hypothesis answerability principle). *The programme standing of a GRE hypothesis increases through discriminating evidence and decreases when seri-*

ous rivals explain the same target more adequately under preserved scope conditions; additional post hoc flexibility should not substitute for evidential answerability.

Some hypotheses may later become domain-specific results. Others may remain productive despite partial defeat because their narrower components continue to generate informative contrasts. Hypothesis status therefore preserves both ambition and vulnerability.

25.2.4 Heuristics

Heuristics perform a different role. They direct attention, organize questions, and help reveal neglected relations without claiming to identify a complete mechanism or exhaustively represent the target. GRE relies on heuristics when it asks researchers to examine relational position, generative conditions, value conversion, circulation, foreclosed possibilities, historical path dependence, or long-horizon effects before assuming that conventional units and metrics capture the relevant problem.

Definition 25.15 (GRE heuristic). A *GRE heuristic* is a disciplined attentional or question-forming device that helps researchers generate observations, contrasts, hypotheses, or alternative representations while carrying weaker truth commitments than the substantive claims that may later be developed from it.

The weaker status of heuristics does not make them methodologically trivial. A heuristic can improve inquiry by revealing systematic blind spots. It can also distort inquiry if it causes researchers to privilege relations where intrinsic properties matter, to search for generativity when transfer explains the phenomenon, or to re-describe ordinary institutional constraint as power. Heuristics therefore need bias analysis and stopping rules.

Proposition 25.16 (Heuristic escalation condition). *When a GRE heuristic is used to support causal, ontological, empirical, or normative conclusions, the resulting stronger claim requires warrant independent of the heuristic's usefulness in directing attention.*

This condition protects the programme from confusing a productive way of looking with evidence that the world necessarily has the structure highlighted by that way of looking.

25.2.5 Formal Representations

Formal representations encode selected structures so that assumptions, relations, transformations, and consequences can be examined with greater precision. The book uses or proposes graph-based, dynamical, field-like, operator-like, category-theoretic, 2-complex, spacetime, and other mathematical representations where they clarify a local problem. Chapter 24 established that formal precision does not itself increase empirical warrant and that transfer of mathematical structure does not transfer ontology automatically.

Definition 25.17 (GRE formal representation). A *GRE formal representation* is a mathematically, logically, diagrammatically, or computationally specified encoding of selected features of a GRE object whose semantics, assumptions, projection losses, and relation to evidence are stated locally.

Formal representations can occupy several epistemic roles. A schematic model may expose logical possibilities. A structural representation may preserve topology,

ordering, dependency, or transformation without empirical parameterization. An analogy may suggest a research question while carrying little direct evidential weight. An empirically parameterized model may support stronger inference when its variables and mechanisms are adequately identified. These roles should remain distinguishable even when they use similar notation.

The book's 2-complex and spacetime representations provide a useful illustration. They can represent history-bearing configurations in which relations and transformations have temporal structure. Their usefulness does not establish that economic reality is fundamentally a 2-complex, spin foam, field, operator algebra, or any other imported mathematical object. Future GRE work may retain the analytical problem while replacing the representation entirely.

Proposition 25.18 (Representation independence principle). *A substantive GRE claim should survive replacement of a non-essential formal representation whenever the replacement preserves the empirically and conceptually relevant structure; dependence on one mathematical vocabulary requires an additional argument showing why that structure is indispensable to the claim.*

25.2.6 Domain-Specific Results

Some components of the present framework have stronger standing only within a particular domain, historical configuration, institutional setting, or evidence base. Their limitation is part of their warrant rather than a defect. GRE treats domain specificity as an epistemic property that should be preserved through later comparison and translation.

Definition 25.19 (Domain-specific GRE result). *A domain-specific GRE result is a finding or supported conclusion whose warrant depends materially on a declared economic domain, historical regime, institutional configuration, population, evidential environment, or neighboring-domain premise and whose transport beyond that setting requires separate justification.*

Domain-specific results can include empirical findings, historically reconstructed mechanisms, institutional analyses, or conclusions imported conditionally from neighboring domains. Their status depends on provenance. A legal premise remains corrigible by legal analysis; an ecological constraint remains answerable to ecological evidence; an AI capability claim remains conditional on the technical and deployment configuration from which it was established. GRE can reason from such premises without absorbing their source-domain authority.

Proposition 25.20 (Domain-result transport condition). *Transport of a domain-specific GRE result requires evidence or argument that the conditions responsible for the result remain sufficiently preserved, or that the relevant changes have been explicitly modeled; recurrence of vocabulary or formal structure alone does not establish transportability.*

The distinction is especially important for the book's cross-domain and historical ambitions. A result can be important precisely because it is local and well established. Generality should be earned through comparison rather than inferred from programme membership.

25.2.7 Open Problems

Open problems identify questions whose resolution can materially alter GRE's explanatory reach, methods, applications, or architecture. Chapter 24 turned limitations into a scope-conditioned research programme; the present final chapter preserves that unfinished state rather than converting the open programme into a completed doctrine.

Definition 25.21 (GRE open problem). A *GRE open problem* is a presently unresolved question for which alternative answers would materially affect at least one substantive claim, analytical proposal, empirical method, domain interface, normative conclusion, or architectural dependency of the programme.

Open problems differ from vague invitations for more research. A well-formed open problem identifies what is unknown, why the unknown matters, which existing claims depend on it, what evidence or conceptual work could discriminate among alternatives, and how different answers would propagate through the framework. Examples include empirical identification of generative mechanisms, conditions of value conversion and circulation, historical transportability, specification of power mechanisms, practical reconstruction of option spaces, long-horizon AI capability dynamics, and the degree to which candidate cross-domain structures survive independent reconstruction.

Proposition 25.22 (Open-problem dependency principle). *An open problem becomes programme-significant when materially different resolutions would alter the warranted status or formulation of connected GRE components; recording those dependencies is part of preserving the programme's future revisability.*

Open problems are therefore part of the theory's present state. Their explicit preservation prevents later researchers from mistaking unanswered questions for silently settled assumptions.

25.2.8 Unresolved Disagreements

The present GRE programme also contains disagreements that should remain unresolved at this stage. These can concern competing ontological readings, alternative formalizations, rival value theories, different accounts of power or justice, competing historical reconstructions, divergent normative premises, or different judgments about the appropriate boundaries of the economic domain. The existence of such disagreement is compatible with programme identity when the competing positions share enough questions, evidence, concepts, and correction procedures to remain mutually contestable.

Definition 25.23 (GRE unresolved disagreement). A *GRE unresolved disagreement* is a documented divergence among serious programme-compatible interpretations, models, premises, or formulations for which the present evidence and argument do not warrant forced convergence and for which the locus of disagreement remains identifiable.

Preserving disagreement requires more structure than listing alternative opinions. The programme should record what the positions share, where their premises or interpretations diverge, which observations or arguments discriminate among them, whether the disagreement is empirical, conceptual, formal, normative, or domain-jurisdictional, and which downstream claims are affected. Some disagreements may

later dissolve because one side is empirically defeated. Others may remain plural because several formulations organize distinct but compatible aspects of the same problem.

Proposition 25.24 (Productive-disagreement principle). *An unresolved disagreement can remain part of GRE when competing formulations preserve explicit points of comparison, accept relevant counterevidence and domain correction, and generate discriminating research within a shared programme structure.*

The eight statuses form the epistemic ledger for the remainder of Chapter 25. Programme unity can coexist with unequal levels of warrant because continuity lies in explicit dependencies and revision pathways rather than equal status across components.

Definition 25.25 (GRE status ledger). A *GRE status ledger* is a versioned record linking programme components to their status, warrant, dependencies, provenance, counterevidence, unresolved alternatives, and revision history.

Proposition 25.26 (Status-preserving programme principle). *GRE remains epistemically coherent when cumulative development can change component status without silent retyping; programme continuity therefore requires preservation of the histories through which warrants strengthen, weaken, or change.*

This discipline prepares Section 571 to state GRE's core commitments without treating every recurring concept as equally foundational or equally established. Core commitments can organize the programme while remaining compatible with revision.

25.3 Core Commitments of GRE

Section 25.2 distinguished the unequal epistemic status of GRE's present components. The present section asks a different question: which commitments organize the programme strongly enough that removing or reversing them would materially alter the kind of economic inquiry GRE has become? Its objective is to identify programme identity without converting present formulations into protected doctrine. The discussion proceeds through relational attention, generative attention, historical situatedness, value plurality, revisability, methodological pluralism, praxis orientation, domain specificity, and openness to counterevidence. The method is dependency-sensitive rather than axiomatic. A commitment counts as core when it shapes questions, evidential burdens, domain boundaries, or revision pathways across multiple parts of the programme, even though the particular concepts through which that commitment is presently expressed may later be revised.

Definition 25.27 (GRE core commitment). A *GRE core commitment* is a programme-level orientation whose removal or reversal would materially alter GRE's characteristic problem selection, inferential discipline, economic domain identity, or revision architecture across a substantial range of its present inquiries.

This definition separates centrality from certainty. A core commitment can organize the programme while remaining philosophically contestable, empirically answerable, and historically revisable. Core status therefore does not promote a heuristic into a fact, a formal representation into an ontology, or a normative proposal into an established moral conclusion.

Proposition 25.28 (Defeasible identity principle). *A commitment can be constitutive*

Table 25.3: Core commitments of the present GRE programme

Commitment	Positive orientation	Principal collapse resisted
Relational attention	Examine positions, dependencies, mediations, and relation-conditioned possibilities	Treating economically relevant objects as context-free isolated units
Generative attention	Ask how capacities, relations, values, institutions, and possibilities come to be formed or transformed	Reducing economic analysis to allocation among already-given objects
Historical situatedness	Index concepts, mechanisms, evidence, and theory to historical conditions	Treating historically formed categories as timeless primitives
Value plurality	Preserve typed value forms, conversion conditions, and evaluative remainders	Assuming one common metric or silent equivalence by default
Revisability	Keep claims, concepts, boundaries, and architectures open to warranted change	Treating programme continuity as preservation of present formulations
Methodological pluralism	Match methods to questions, objects, evidence, and uncertainty	Treating one method as universally epistemically prior
Praxis orientation	Examine consequences of inquiry and intervention under incomplete knowledge	Separating economic understanding categorically from practical consequence
Domain specificity	Maintain GRE as an economic research programme with explicit neighboring-domain interfaces	Conflating economic inquiry with a completed general relational theory
Openness to counterevidence	Require adverse evidence to be able to lower warranted claim status	Protecting GRE through semantic expansion or ad hoc exception

of GRE's present programme identity without being immune to counterevidence or architectural revision; programme identity is therefore versioned rather than doctrinally fixed.

Table 25.3 summarizes the nine commitments developed below. The final column states the principal collapse that each commitment is intended to prevent. These are disciplines of inquiry rather than claims that one theoretical vocabulary exhausts the relevant phenomenon.

25.3.1 Relational Attention

Relational attention is one of GRE's most visible commitments, but its meaning is narrower than an assertion that reality is fundamentally composed of relations. The programme asks how economically relevant positions, capacities, constraints, values, institutions, and possibilities are constituted, conditioned, or transformed through relations with other positions and structures. This attention can reveal dependencies and mediated effects that disappear when an analytical object is treated as self-contained.

Definition 25.29 (Relational-attention commitment). The *relational-attention commitment* is the programme-level requirement that GRE test whether the economic properties attributed to an object depend materially on its relations, relational posi-

tion, interaction history, institutional embedding, or participation in larger relational configurations.

The commitment is diagnostic rather than totalizing. Some properties can be usefully analyzed at the level of an individual object, material constraint, technical characteristic, or domain-specific mechanism. Chapter 24 already established that relational explanation should not become relational reduction. The core commitment is therefore to ask the relational question where it is consequential, not to force every explanandum into one relational ontology.

Relational attention also carries a burden of typing. Communication is not automatically trust; exchange is not automatically dependence; co-membership is not automatically authority; correlation is not automatically relation; and relation is not automatically power. The programme's relational identity depends partly on preserving these distinctions rather than using "relation" as a universal residual category.

Proposition 25.30 (Relational attention without relational exhaustiveness). *GRE's relational commitment requires systematic testing of relation-conditioned economic properties, but it does not require every economically consequential property or mechanism to be exhaustively relational in constitution or explanation.*

25.3.2 Generative Attention

Generative attention gives GRE its second major orientation. The programme does not examine only how scarce resources are allocated among already specified agents, goods, institutions, and preferences. It asks how economic processes help form, transform, sustain, close, or regenerate the capacities, relations, institutions, value forms, categories, and option spaces through which later economic action becomes possible.

Definition 25.31 (Generative-attention commitment). The *generative-attention commitment* is the requirement that GRE investigate whether an economic process changes the conditions under which later economically relevant subjects, relations, capacities, values, institutions, or feasible possibilities can arise and persist.

This commitment is not a license to call every change generative. Chapters 12–15 and the value-theoretical and empirical-identification discussions of Chapter 24 distinguish generation from transfer, conversion, circulation, selection, revelation, persistence, redistribution, and reclassification. Chapter 24 further makes generativity answerable to discriminating evidence. Generative attention is core because GRE repeatedly asks how possibility conditions themselves change; the present taxonomy of generative mechanisms is not core in the same sense and can be revised.

The commitment also remains normatively neutral until an independent evaluative bridge is supplied. Generative processes can expand capabilities, reproduce domination, create ecological harm, generate exclusion, or multiply possibilities that are costly or destructive. The programme therefore treats generativity as an analytical object rather than a synonym for improvement.

Proposition 25.32 (Generative attention without generative valorization). *GRE treats changes in later conditions of possibility as analytically important while requiring separate evidence and normative warrant for claims that those changes are beneficial, just, desirable, or worthy of preservation.*

25.3.3 Historical Situatedness

GRE treats economic objects and the theory used to study them as historically situated. Markets, currencies, firms, property regimes, technologies, categories of work, forms of knowledge, legal institutions, social identities, and AI-mediated capabilities have histories that condition their present economic roles. Analytical vocabulary also has a history. A concept can therefore become misleading when transported across periods without reconstructing the institutions, categories, and manifestation regimes through which it acquired meaning.

Definition 25.33 (Historical-situatedness commitment). The *historical-situatedness commitment* is the requirement that GRE state or reconstruct the historical conditions under which its economically relevant objects, categories, mechanisms, evidence, and theoretical formulations acquire their present meanings and ranges of validity.

Historical situatedness does not imply that every proposition is unique to one moment or that comparison across periods is impossible. It changes the burden of generalization. Recurrence across historical regimes becomes evidence to be established rather than presumed. Fast-slow relations, criticality hypotheses, institutional persistence, power continuity, and cross-period category bridges are consequently regime-bounded claims unless stronger evidence supports wider transport.

The same requirement applies reflexively to GRE. The present programme is a product of a particular historical problem field and should remain reconstructable as its objects and conditions change. Historical revision is therefore not merely an external possibility discussed later in this chapter; it is already part of GRE's core identity.

Proposition 25.34 (Historical transport burden). *A GRE concept or mechanism does not acquire transhistorical status merely because it is analytically productive in the present; transport across periods requires evidence that its constitutive conditions or a defensible bridge among those conditions are preserved.*

25.3.4 Value Plurality

GRE's value architecture begins from the possibility that economically relevant value is heterogeneous. Monetary value, capability, knowledge, ecological conditions, recognition, institutional standing, relational goods, future options, and other value-bearing forms need not share one natural metric. The programme therefore treats conversion, circulation, commensuration, aggregation, and compensation as questions requiring explicit mechanisms and warrants.

Definition 25.35 (Value-plurality commitment). The *value-plurality commitment* is the presumption that economically relevant value forms should remain typed and potentially non-equivalent unless a common representation, conversion rule, comparison operation, or normative ordering is independently warranted for the task at hand.

The word *presumption* is important. Chapter 24 makes value plurality itself revisable. A sufficiently powerful common representation could outperform a heterogeneous architecture in a specified domain, while poorly distinguished value categories could create unnecessary conceptual inflation. GRE's core commitment is therefore not to maximize the number of value forms. It is to avoid silent scalarization and to preserve value remainders until equivalence has been earned.

This commitment also distinguishes practical settlement from value identity. In-

stitutions frequently make decisions by imposing prices, scores, rankings, thresholds, rights, budgets, or optimization criteria. Such commensuration can be practically necessary without proving that the underlying values are substantively equivalent or fully represented by the settlement rule.

Proposition 25.36 (Plurality-before-equivalence principle). *When several value-bearing dimensions are materially relevant, GRE should preserve their distinct typing until the comparison or conversion relation required for a particular inference has been justified; practical commensuration alone does not establish general value equivalence.*

25.3.5 Revisability

Revisability is more than an acknowledgement that future research may change conclusions. Chapters 24–25 treat revision as an internal property of the programme. Claims have defeat conditions; concepts can be narrowed, retyped, decomposed, merged, regionalized, or retired; formal representations can be replaced; domain boundaries can move; and sufficiently recurrent failure can trigger architectural revision.

Definition 25.37 (GRE revisability commitment). *The GRE revisability commitment is the requirement that substantive claims, conceptual distinctions, formal representations, domain boundaries, and programme architecture remain linked to identifiable conditions under which their warranted status or formulation should change.*

Revisability differs from vagueness. A framework is not more open merely because its concepts can be stretched to accommodate any observation. Genuine revisability requires sufficiently stable semantics for evidence to count against a claim. It also differs from indiscriminate novelty. Revision should be proportionate to the locus and severity of defeat, preserving well-supported local results when a broader component changes.

Proposition 25.38 (Revision-with-continuity principle). *GRE programme continuity depends on recoverable histories of why components changed rather than on preservation of their current wording; justified revision can therefore strengthen programme identity when provenance and dependency relations remain explicit.*

25.3.6 Methodological Pluralism

GRE does not assign one universal hierarchy to historical interpretation, qualitative inquiry, quantitative analysis, formal modelling, comparative research, institutional reconstruction, participatory methods, or computational methods. Different questions expose different aspects of relational and generative economic processes, and several methods can be necessary to identify one mechanism adequately.

Definition 25.39 (Methodological-pluralism commitment). *The methodological-pluralism commitment is the requirement that GRE select and combine methods according to the structure of the research question, object, evidence, uncertainty, and inferential burden rather than according to a fixed programme-wide methodological hierarchy.*

Pluralism is not methodological permissiveness. A method still has to answer the relevant question. Historical narrative cannot substitute for identification where a causal contrast is required; formal elegance cannot substitute for measurement;

quantitative precision cannot repair a mis-specified concept; qualitative interpretation cannot by itself establish prevalence; and participatory input does not automatically establish representativeness or normative authority. The commitment is to question-sensitive adequacy rather than equal authority for every method in every task.

Proposition 25.40 (Method-to-question adequacy principle). *Methodological pluralism strengthens GRE only when the contribution and limitation of each method to the target inference are stated; plurality of methods does not by itself increase warrant when their errors, assumptions, or evidential sources are shared.*

25.3.7 Praxis Orientation

GRE was developed not only to describe economic structures but also to support inquiry into allocation, institutional design, intervention, governance, participation, and future possibility under incomplete knowledge. Praxis orientation links explanation to the consequences of acting, delaying, maintaining, redesigning, or withdrawing interventions. It does not require every GRE study to recommend action, nor does it collapse research into advocacy.

Definition 25.41 (Praxis-orientation commitment). The *praxis-orientation commitment* is the requirement that GRE remain capable of connecting warranted economic understanding to the conditions, consequences, uncertainties, affected positions, revision possibilities, and responsibilities of practical intervention where action is part of the research problem.

Praxis orientation is constrained by the epistemic discipline developed earlier in the book. Intervention does not strengthen weak evidence merely because a decision is urgent. Applied reasoning should preserve uncertainty, value conflict, participation limits, institutional capacity, irreversibility, and consequences of non-action. Conversely, indefinite deferral is not neutral when delay itself redistributes burden or forecloses options.

Proposition 25.42 (Praxis without compulsory intervention). *GRE's praxis commitment requires practical consequences to remain analytically visible where relevant, but it does not require every research result to terminate in intervention; non-intervention, observation, reversible experimentation, or further inquiry can be warranted outcomes of praxis-sensitive analysis.*

25.3.8 Domain Specificity

GRE is an economic research programme. Its relational and generative vocabulary can enter history, law, governance, education, ecology, AI studies, political theory, social theory, aesthetics, and other neighboring domains, but such movement does not erase domain-specific objects or correction authority. Chapter 23 made disciplinary containment and reciprocal correction central to cross-domain inquiry, while Chapter 24 made failed transfer part of the programme's limitation record.

Definition 25.43 (Domain-specificity commitment). The *domain-specificity commitment* is the requirement that GRE identify its principal economic problem-space and distinguish economic claims from historical, legal, political, ecological, educational, technical, aesthetic, social, or other claims whose warrants must be supplied or corrected by their relevant domains.

Domain specificity prevents two opposite failures. GRE should not isolate economic inquiry from the non-economic relations that constitute or condition economic processes. It should also not absorb every consequential relation into economics. The appropriate unit of jurisdiction is often the predicate or claim rather than the whole empirical object.

This commitment also limits the relation between GRE and a possible future Generative Relational Theory (GRT). GRE can supply comparative evidence and candidate structures, but successful economic formalization does not establish universal GR primitives. A future GRT would need stronger cross-domain and cross-historical evidence than the present book provides.

Proposition 25.44 (Economic-domain identity principle). *GRE remains recognizably economic when its principal explanatory and practical questions concern economically relevant allocation, generation, value, capability, institution, exchange, conversion, circulation, power, and possibility structures while neighboring-domain predicates retain their independent warrants and correction pathways.*

25.3.9 Openness to Counterevidence

Openness to counterevidence is the strongest discipline among the present commitments because it determines whether the others remain research commitments rather than identity-protecting doctrines. Chapter 24 specifies both evidential defeat conditions and the circumstances under which repeated defeat should escalate to architectural revision. The final programme therefore requires more than willingness to discuss criticism. Relevant adverse evidence must be capable of changing warranted status.

Definition 25.45 (Counterevidence-openness commitment). The *counterevidence-openness commitment* is the requirement that GRE formulate consequential claims and programme components so that sufficiently relevant adverse evidence, rival explanations, replication failures, domain counterexamples, or internal inconsistencies can lower, narrow, retype, replace, or retire them.

This commitment prevents the programme from becoming self-sealing. Relational explanation cannot be protected by redefining every causal factor as relational. Generativity cannot be protected by labeling every change generation. Value plurality cannot be protected by multiplying categories whenever comparison succeeds. Domain specificity cannot be protected by treating every failed transfer as irrelevant. Revisability therefore becomes genuine only when evidential loss has consequences.

Proposition 25.46 (Identity-through-answerability principle). *GRE's programme identity is strengthened, rather than weakened, when adverse evidence can change its components through declared defeat and revision pathways; answerability is therefore part of what makes the programme recognizable across revisions.*

The nine commitments should not be read as an axiom list whose elements must remain textually unchanged. They form a present identity profile. Relational and generative attention specify characteristic questions; historical situatedness and value plurality constrain how objects and evaluative forms are typed; methodological pluralism and praxis orientation shape inquiry and intervention; domain specificity regulates external interfaces; revisability and counterevidence preserve the possibility that all of these commitments can themselves be reconsidered.

Definition 25.47 (GRE programme identity kernel). The *GRE programme identity kernel* is the mutually constraining configuration of core commitments through which the present programme selects problems, organizes evidence, limits its domain, and remains answerable to revision, without requiring one immutable vocabulary, method, formalism, or metaphysical doctrine.

Proposition 25.48 (Core-commitment interaction principle). *No single present core commitment is sufficient to identify GRE in isolation; the programme is characterized by their joint operation, including the tensions through which one commitment limits the overextension of another.*

This interaction prepares Section 572 to state the corresponding non-commitments. A programme becomes clearer not only by identifying what it requires, but also by stating which stronger metaphysical, formal, methodological, normative, disciplinary, and general-theoretical conclusions do not follow from those requirements.

25.4 Boundaries of GRE Programme Commitment

Section 25.3 identified the orientations that presently make GRE recognizable as a research programme. The present section states the complementary boundary conditions on those commitments. Its objective is to prevent the programme identity described in the preceding section from being silently strengthened into metaphysical doctrine, formal exclusivity, value monism, historical teleology, methodological hierarchy, normative automaticity, disciplinary replacement, or premature general theory. The discussion proceeds through eight commitment boundaries. The method is inferential: for each boundary, the section asks which stronger conclusion does not follow merely from accepting GRE's core commitments and what additional warrant would be required before that stronger conclusion could responsibly be adopted.

Definition 25.49 (GRE programme non-commitment). A *GRE programme non-commitment* is a stronger metaphysical, formal, evaluative, historical, methodological, normative, disciplinary, or general-theoretical conclusion that is not entailed by GRE's present core commitments and therefore requires independent warrant before it can be attributed to the programme.

A non-commitment is not a declaration that the stronger position is false. Some stronger positions may later prove useful, empirically supported, philosophically defensible, or locally necessary. The point is narrower: GRE does not acquire them merely by virtue of being relational, generative, historically situated, pluralist, praxis-oriented, domain-specific, revisable, and open to counterevidence.

Proposition 25.50 (Commitment asymmetry principle). *GRE's core commitments constrain how inquiry should proceed, but they do not automatically authorize stronger conclusions about ultimate ontology, universal formal language, complete value commensuration, historical direction, methodological supremacy, normative priority, disciplinary replacement, or general relational theory.*

Table 25.4 summarizes the eight boundaries developed below. The final column states the additional kind of warrant that would be needed before the stronger conclusion could move from external possibility to warranted GRE commitment.

Table 25.4: Boundaries of present GRE programme commitment

Boundary	Conclusion not supplied by GRE alone	Additional warrant required
Metaphysical scope	Relations constitute ultimate reality	Independent metaphysical argument and domain-appropriate evidence
Formal scope	One mathematical language is universally privileged	Demonstrated indispensability across problem classes and domains
Value metrics	Heterogeneous values reduce to one complete metric	Justified commensuration preserving materially relevant distinctions
Historical direction	Generative history converges toward a predetermined end	Independent historical and normative warrant for directional necessity
Method choice	One method is epistemically supreme for GRE	Scope-specific evidence that rivals systematically fail for the task
Normative priority	More generativity is automatically better	Explicit normative bridge concerning what, for whom, and at what cost
Disciplinary role	GRE supersedes existing economics	Comparative explanatory and empirical superiority over defined scopes
General theory	GRE establishes a completed GRT	Independent cross-domain and cross-historical reconstruction and testing

25.4.1 Metaphysical Suspension

GRE's relational attention is analytically strong but metaphysically restrained. The programme often studies entities, institutions, capacities, values, and economic positions as historically sustained relational configurations, and it distinguishes relational reality from the manifestations through which that reality becomes accessible. Neither move establishes that ultimate reality is fundamentally relational, processual, field-like, or otherwise exhausted by the conceptual language used for inquiry.

Definition 25.51 (Metaphysical suspension boundary). The *metaphysical suspension boundary* is the programme condition under which GRE may use relational, processual, field-theoretic, geometric, spacetime, or related ontological vocabularies analytically while withholding the stronger claim that any such vocabulary has established the final constitution of reality.

This boundary matters because successful explanation within a relational representation is weaker than metaphysical proof. A relation-sensitive account of ownership, trust, currency, institutional standing, or economic power can outperform an atomistic account without showing that all properties of the relevant objects are relational in ultimate ontology. Likewise, the practical persistence and causal efficacy of relationally constituted objects do not settle whether deeper material, biological, phenomenological, physical, or otherwise differently characterized structures also matter.

The metaphysical boundary therefore protects GRE from converting explanatory usefulness into ontological necessity. It also protects future inquiry. If a later domain

develops stronger reasons for a different ontological reading, GRE can revise its representation without requiring the entire economic programme to collapse.

Proposition 25.52 (Analytical success without metaphysical closure). *Successful relational explanation can support the adequacy of a relational representation for a declared economic problem without establishing that the represented relation or structure is the unique or ultimate ontology of its target.*

25.4.2 Formal Plurality

The same restraint applies to formal language. This book has used or discussed networks, dynamical systems, field-like descriptions, operator-like transformations, category-theoretic relations, history-bearing complexes, and other formal resources. These formalisms are not interchangeable, and their coexistence should not be interpreted as a search for one notation into which every GRE problem must eventually be translated.

Definition 25.53 (Formal plurality boundary). *The formal plurality boundary is the requirement that GRE select formal structures according to the local analytical object, inferential burden, empirical correspondence, and representational gain rather than presuming one mathematical language to be universally privileged.*

A universal formalism would require much stronger evidence than repeated usefulness. It would have to preserve the distinctions required across substantially different problems, permit warranted empirical interpretation, and outperform serious alternatives without acquiring its universality by semantic dilution. A formalism that can represent everything only because its primitives have become indefinitely permissive offers little discriminating advantage.

The book's preferred advanced formalisms should therefore remain defeasible. A 2-complex can be useful for representing history-bearing relational structures; an operator-like language can be useful for typed transformations; field language can be useful where distributed structure adds explanatory discrimination. None thereby becomes GRE's obligatory syntax.

Proposition 25.54 (Formal non-exclusivity principle). *No formal representation used in the present GRE programme acquires universal authority from elegance, recurrence, or successful local application alone; continued use remains conditional on locally demonstrated analytical and evidential adequacy.*

25.4.3 Value-Metric Plurality

Value plurality is a core commitment because the book repeatedly encounters value forms whose realization conditions, temporal structures, affected positions, and normative warrants differ. The corresponding non-commitment is not a doctrine of absolute incommensurability. GRE does not require that heterogeneous values can never be compared, aggregated, exchanged, translated, or represented under a common decision rule. It requires the bridge enabling such operations to be justified rather than silently assumed.

Definition 25.55 (Value-metric plurality boundary). *The value-metric plurality boundary is the programme condition under which heterogeneous value forms remain separately typed until a comparison or aggregation rule has demonstrated sufficient va-*

lidity for the declared purpose without erasing distinctions material to the inference or decision.

This boundary permits partial and local commensuration. Monetary valuation can answer some allocation questions; multicriteria systems can structure some policy comparisons; thresholds can protect non-substitutable claims; deliberation can settle action without producing a cardinal common measure. The existence of these procedures does not establish that the underlying values are one substance, and their absence in another case does not prove that all comparison is impossible.

The programme therefore rejects both premature monism and automatic incommensurability. The appropriate question is operation-specific: which values are being compared, through what rule, for which decision, with which remainder, and under whose authority?

Proposition 25.56 (Commensuration without metric monism). *GRE can accept locally warranted comparison, translation, or aggregation among heterogeneous values without committing to one complete metric that preserves every economically or normatively material value distinction.*

25.4.4 Historical Contingency and Directional Restraint

Generative analysis is inherently historical because it asks how later capacities, structures, institutions, relations, and possibilities arise from earlier configurations. That temporal orientation does not entail teleology. A generative process need not move toward progress, efficiency, justice, complexity, equilibrium, freedom, or any other predetermined endpoint.

Definition 25.57 (Historical non-teleology boundary). *The historical non-teleology boundary is the requirement that GRE explain historical generation through contingent mechanisms, constraints, branching possibilities, closures, feedback, and path dependence without inferring predetermined direction or normative progress from generation itself.*

The boundary is especially important because retrospective narratives easily convert realized outcomes into apparent destinations. Once a monetary institution, technological standard, firm form, welfare regime, or political economy becomes durable, its persistence can make earlier alternatives appear less possible than they were. GRE should instead preserve failed, unrealized, or foreclosed alternatives when they are necessary for understanding the historical possibility structure.

This does not rule out directional tendencies. Some regimes can produce cumulative concentration, capability expansion, increasing dependence, ecological depletion, or other recurrent trajectories. Such tendencies remain historically conditioned mechanisms rather than evidence that history as a whole possesses an intrinsic destination.

Proposition 25.58 (Generation without historical destination). *The identification of generative mechanisms, cumulative dynamics, or path dependence does not by itself establish a necessary historical endpoint or a normative ranking of the direction in which the system changes.*

25.4.5 Methodological Plurality and Local Adequacy

Methodological pluralism implies more than tolerance among methods. It denies that GRE's identity is tied to one universally superior route to knowledge. Historical reconstruction, ethnography, interpretation, comparative institutional analysis, qualitative inquiry, statistics, causal inference, formal modeling, simulation, archival research, and computational methods can answer different parts of a relational-generative problem.

Definition 25.59 (Methodological non-exclusivity boundary). The *methodological non-exclusivity boundary* is the requirement that no method receive programme-wide epistemic priority independent of the question, target, evidence structure, uncertainty, and inferential task for which it is being used.

The boundary does not imply that every method is equally adequate for every problem. Methodological pluralism permits strong local judgments. A carefully identified natural experiment may answer one causal question better than interpretive evidence; archival reconstruction may answer another question that contemporary measurement cannot reach; formal modeling may reveal consequences of assumptions that descriptive prose leaves obscure. The pluralist commitment concerns the absence of a universal hierarchy, not the absence of methodological criticism.

It also resists a subtler hierarchy in which formalization is treated as the final stage of theoretical maturity. Some GRE questions can be formalized productively; others may lose essential historical, semantic, normative, or institutional structure when forced into a prematurely closed formal space.

Proposition 25.60 (Method-to-question priority). *Within GRE, methodological adequacy is assessed relative to the research question and inferential burden; the programme does not rank historical, interpretive, empirical, qualitative, quantitative, formal, or computational methods by one context-independent order of epistemic prestige.*

25.4.6 Generativity and Normative Independence

Generativity is analytically central to GRE, but the programme does not treat generativity itself as a complete normative standard. The capacity to generate more options, capabilities, institutions, relations, values, or future pathways can be economically important while remaining ethically or politically ambiguous. Systems can generate capacities for domination, extraction, surveillance, ecological degradation, manipulation, or exclusion as well as capacities that many normative frameworks would value positively.

Definition 25.61 (Normative independence of generativity). The *generativity-normativity separation* is the programme condition under which a claim that a process generates or preserves economically relevant capacities, relations, values, or possibilities remains analytically distinct from the normative judgment that such generation or preservation is good, just, legitimate, or worthy of priority.

This separation also prevents a reverse error. A process can be normatively important even when it is not highly generative. Protection of a vulnerable relation, ecological threshold, legal right, historical memory, or non-substitutable value may require limiting some forms of generation or option expansion. The normative question therefore concerns what is generated, for whom, through which burdens and

relations, relative to which alternatives, and under which warranted evaluative principles.

Proposition 25.62 (Normative bridge requirement for generativity). *A GRE claim about generative capacity acquires normative priority only through an additional evaluative bridge that specifies the value, standing, distribution, burden, temporal horizon, and relevant alternatives associated with what is generated or preserved.*

25.4.7 Complementarity with Existing Economics

GRE has been developed partly because important economic questions are obscured when actors, values, institutions, histories, and possibilities are treated as already given. This motivation does not imply that existing economics should be displaced wholesale. Price theory, game theory, econometrics, industrial organization, public economics, macroeconomics, behavioral economics, institutional economics, political economy, and other traditions contain methods and explanations that can remain highly effective within their appropriate scopes.

Definition 25.63 (Disciplinary complementarity boundary). *The disciplinary complementarity boundary is the programme condition under which GRE presents its concepts and methods as additions, reconstructions, critiques, or alternatives for specified economic problems rather than as a presumptive replacement for the heterogeneous bodies of existing economics.*

Replacement is a comparative claim. It requires demonstrating that GRE explains or supports inquiry better for a defined problem while preserving relevant empirical adequacy and avoiding excessive auxiliary assumptions. In many cases, GRE may instead supply a prior question about how preferences, capabilities, institutions, market categories, or feasible sets were generated before a conventional model analyzes behavior within the resulting structure.

This complementarity also keeps dialogue reciprocal. Existing economic theories can expose where GRE is unnecessarily elaborate, insufficiently identified, formally weak, empirically redundant, or unable to reproduce well-established results. GRE's openness to such criticism is part of its programme identity rather than a concession outside it.

Proposition 25.64 (Problem-relative disciplinary contribution). *GRE's contribution to economics should be judged problem by problem through explanatory, empirical, conceptual, and practical comparison; the existence of GRE does not entail the obsolescence of theories whose assumptions remain adequate for their declared tasks.*

25.4.8 Deferred General Relational Unification

GRE is a domain instantiation developed with preliminary GR foundations, not a completed general Generative Relational Theory. The recurrence of relation, generation, history, constraint, manifestation, power, field, or related vocabulary across neighboring domains can motivate comparison, but recurrence is not sufficient evidence of a domain-general invariant. Shared intellectual ancestry can itself produce apparent cross-domain regularity.

Definition 25.65 (Deferred general-unification boundary). *The deferred general-unification boundary is the requirement that claims about a general Generative*

Relational Theory remain provisional until independently developed domains provide sufficiently discriminating cross-domain and cross-historical evidence for shared structures that survive domain-specific reconstruction, counterexamples, translation failure, and alternative formulations.

This boundary leaves open several possible futures. Comparative work may reveal robust invariants worthy of GRT-level formulation. It may instead reveal families of related but irreducible domain theories, or a thinner common grammar whose explanatory content remains primarily local. The present book does not decide among these futures.

The strongest evidence for generality would not be that multiple domains repeat vocabulary introduced from the same source. It would be that independently constituted inquiries encounter structurally comparable problems, reconstruct analogous mechanisms using their own evidence and methods, survive serious domain-specific counterexamples, and still retain a non-trivial shared structure after the domain-specific remainder is restored.

Proposition 25.66 (Generality after independent reconstruction). *A future GRT claim would be strengthened when independently developed domains rediscover a structurally comparable relation after domain-specific reconstruction and adversarial testing; designed recurrence within a shared vocabulary is insufficient by itself.*

The eight boundaries developed in this section complete the identity profile begun in Section 25.3. GRE is presently recognizable through what it asks researchers to attend to and through the stronger conclusions it refuses to acquire automatically. The resulting programme is relational without requiring final relational metaphysics; formally ambitious without formal monism; value-plural without declaring universal incommensurability; historical without teleology; methodologically plural without suspending methodological judgment; generative without automatic normative valorization; economically distinctive without claiming disciplinary replacement; and connected to GR without prematurely claiming a completed GRT.

Definition 25.67 (GRE commitment boundary profile). *The GRE commitment boundary profile is the paired specification of present core commitments and present non-commitments that jointly identifies what the programme requires for recognizable inquiry and which stronger conclusions remain outside that requirement absent independent warrant.*

Proposition 25.68 (Programme identity through bounded commitment). *GRE's identity is more precisely preserved when core commitments are paired with explicit non-commitments, because the pair constrains both conceptual dilution and theoretical overreach while leaving future revision possible.*

This bounded identity prepares Section 573 to examine GRE as a language of economic inquiry. A research language is useful not because every concept it contains is mandatory or universally true, but because it makes certain questions, distinctions, translations, comparisons, reconstructions, and limits easier to state and contest.

25.5 GRE as a Language of Economic Inquiry

Sections 25.3–25.4 specified what presently identifies GRE and which stronger conclusions do not follow from that identity. The present section develops a different aspect of programme identity: GRE can function as a language of economic inquiry.

The objective is not to redescribe the economy in one mandatory vocabulary, but to identify a disciplined set of questions, distinctions, translation practices, comparison procedures, reconstruction tasks, formalization choices, and dialogical interfaces that make particular economic problems easier to state and contest. The section proceeds through eight functions of this language and closes by specifying its limits. The method is functional rather than metaphysical: the adequacy of the language is judged by what it helps inquiry discriminate, reconstruct, compare, and revise, not by whether its vocabulary is presumed to mirror the ultimate structure of reality.

Definition 25.69 (GRE inquiry language). A *GRE inquiry language* is a revisable set of problem-framing concepts, distinctions, question forms, representational resources, and inferential disciplines used to investigate economically relevant relational generation, transformation, value, history, power, and possibility without requiring those resources to constitute a universal description of economic reality.

The word *language* is deliberately broad but bounded: it includes prose, technical distinctions, diagrams, formal representations, comparative schemas, and question structures. It neither implies one complete formal language nor requires GRE terminology. Different vocabulary can address a GRE-relevant problem when the relevant analytical distinctions are preserved.

Proposition 25.70 (Interrogative priority of GRE language). *The primary value of GRE as an inquiry language lies in improving the questions and distinctions through which economic phenomena are investigated; adoption of GRE vocabulary is secondary to preservation of the analytical work performed by those questions and distinctions.*

Table 25.5 summarizes the eight functions developed below. The final row is intentionally limiting: every inquiry language makes some phenomena easier to notice and others easier to obscure, so reflexive criticism of the language belongs inside the programme.

25.5.1 Question Architecture

An inquiry language first changes what can be asked economically. Standard economic questions often begin with already specified actors, preferences, resources, institutions, constraints, technologies, and feasible sets. Those questions remain important. GRE adds a prior and complementary family of questions concerning how these objects became available, stable, recognized, convertible, valuable, or actionable in the first place.

Definition 25.71 (GRE question architecture). The *GRE question architecture* is the recurrent family of questions that asks how economically relevant subjects, relations, capacities, institutions, values, constraints, classifications, and possibilities are generated, sustained, transformed, converted, circulated, foreclosed, or rendered manifest within historical and relational conditions.

The architecture does not require every study to investigate every process. A labor-market study may examine credential recognition; an institutional study, legal categories and conversion; an historical study, relations making later market forms feasible; an AI-era study, organizational conditions converting technical into economic capability. The shared feature is attention to how the conditions of familiar economic objects are generated or transformed.

Questions themselves can nevertheless overreach. A question such as “which re-

Table 25.5: Functions and limits of GRE as a language of economic inquiry

Function	Principal contribution	Discipline required
Questions	Makes generation, relation, history, value, and possibility explicit objects of inquiry	Do not presume the answer in the wording of the question
Distinctions	Separates mechanisms that ordinary vocabulary can conflate	Preserve type differences and allow later retyping
Translation	Relates vocabularies across theories, domains, and historical settings	Record semantic loss, remainder, and correction authority
Comparison	Makes similarities and differences inspectable without presuming equivalence	State the comparison task and dimensions explicitly
Reconstruction	Organizes inference from traces toward histories and relational structures	Preserve uncertainty, alternatives, and inverse-problem limits
Formalization	Provides precise representations where additional structure earns analytical value	Define semantics locally and avoid ontology by notation
Dialogue	Supports contestable exchange among theories, disciplines, and practical positions	Permit external concepts and counterevidence to revise GRE
Language limits	Reveals blind spots, semantic inflation, and compulsory-vocabulary risks	Treat the language itself as revisable research infrastructure

lation generated the outcome?” already assumes that the outcome was generated through a relation rather than selected, transferred, revealed, or produced through a mixed mechanism. GRE therefore requires questions to remain rival-sensitive.

Proposition 25.72 (Question non-presupposition principle). *A GRE-framed question should make relational or generative possibilities investigable without building the truth of a specifically relational or generative explanation into the question itself.*

25.5.2 Analytical Distinctions

A second function of the GRE language is distinction. Much of the book’s architecture depends on refusing to use one term for several analytically different operations: generation differs from transfer; conversion differs from circulation; circulation differs from return; stability differs from goodness; generativity differs from normative desirability; formal equivalence differs from ontological identity; economic agency differs from legal personality or moral standing.

Definition 25.73 (GRE distinction set). *A GRE distinction set is a locally justified separation among concepts or mechanisms whose conflation would materially change the interpretation, evidence, or consequence of an economic claim.*

The requirement of local justification matters. A language can become unusable if it multiplies distinctions indefinitely. GRE should preserve a distinction when the separated categories differ in evidence, mechanism, normative implication, domain authority, temporal structure, or revision condition. When a distinction does no ana-

lytical work, maintaining it merely because it appears elsewhere in the programme produces terminological burden rather than precision.

The same principle permits later retyping. A distinction that initially appears important may prove empirically redundant; conversely, a category treated as unitary may later require decomposition. The inquiry language should therefore support sharper typing without turning early classifications into permanent ontological commitments.

Proposition 25.74 (Distinction adequacy principle). *A GRE distinction earns continued use when preserving it improves empirical discrimination, inferential clarity, normative transparency, domain containment, or revision capacity relative to plausible simpler classifications.*

25.5.3 Translation across Vocabularies

Economic inquiry rarely occurs within one vocabulary. Terms travel among theories, disciplines, institutions, historical periods, policy systems, and everyday practices. GRE therefore requires translation, but Chapter 23 established that translation does not establish identity. The present section recasts that lesson as a property of the inquiry language itself.

Definition 25.75 (Inquiry-language translation). *Inquiry-language translation* is the explicit mapping of a concept, distinction, question, or formal object from one vocabulary into another while preserving the dimensions required for the intended inquiry and recording dimensions that are transformed, lost, or left without an equivalent.

A legal status can be economically consequential without being reducible to an economic position; an ecological threshold can constrain economic possibility without becoming an economic value; an educational capability can affect economic conversion without being exhausted by its economic effect. Translation should therefore identify the purpose for which correspondence is being claimed. A translation adequate for tracing economic consequences may be inadequate for evaluating legal validity or educational quality.

Semantic remainder therefore has a constructive role: incomplete translation can reveal receiving-domain distinctions, GRE-specific assumptions, or the need for a new interface concept.

Proposition 25.76 (Purpose-bounded translation principle). *The adequacy of a GRE translation is relative to the declared inferential purpose; successful translation for one economic question does not authorize unrestricted substitution of the translated concepts across other questions or domains.*

25.5.4 Comparison without Premature Equivalence

Comparison is closely related to translation but performs different work. Translation asks how one vocabulary can be related to another. Comparison asks along which dimensions two objects, mechanisms, histories, institutions, or theories should be treated as similar or different. GRE's relational orientation makes comparison especially important because apparent similarity at the level of outcomes can coexist with substantial differences in relational constitution or historical production.

Definition 25.77 (GRE comparison frame). *A GRE comparison frame* is an explicit

specification of the comparison object, dimensions, historical and institutional scope, evidential basis, and inferential purpose through which similarities and differences are assessed.

A comparison frame prevents lexical identity from carrying excessive inferential weight. Institutions called “markets” can differ in membership, law, authority, value forms, power, and historical formation; apparent capability gains can arise through different mechanisms; mathematically similar models can represent different empirical objects.

Comparison can also reveal invariance. When a structure survives substantial variation in vocabulary, history, domain, and representation, it becomes a stronger candidate for broader generalization. Yet the comparison itself should remain prior to the inference of invariance.

Proposition 25.78 (Comparison-before-equivalence principle). *GRE should establish the dimensions and limits of comparison before inferring equivalence, invariance, portability, or common mechanism from observed similarity.*

25.5.5 Historical and Relational Reconstruction

GRE also functions as a language of reconstruction. Many economically consequential relations cannot be observed directly, and many historical processes are accessible only through incomplete traces, manifestations, institutional records, classifications, testimony, or later outcomes. Inquiry therefore often proceeds backward from partial evidence toward plausible relational histories.

Definition 25.79 (GRE reconstruction language). The *GRE reconstruction language* is the set of concepts used to state how present or recorded manifestations support bounded inferences about past or latent relational structures, mechanisms, and possibility conditions while preserving alternative reconstructions and evidential limits.

Reconstruction should make uncertainty representable rather than append a generic caveat. Reconstruction envelopes, compatibility classes, hidden relations, historical horizons, missingness, and rival mechanisms help specify where several histories remain compatible with the evidence.

Reconstruction is also necessary for apparently stable economic objects. Money, property, firms, credentials, technological capability, or institutional authority can appear as present entities while depending on long historical processes of stabilization and recognition. Reconstruction asks which parts of those histories remain causally or constitutively relevant to the present claim.

Proposition 25.80 (Bounded reconstruction principle). *GRE reconstruction should support conclusions only at the level of detail stable across serious evidential alternatives; greater narrative completeness should not be inferred merely because the inquiry language can describe a more complete history.*

25.5.6 Selective Formalization

Formalization is another component of the inquiry language, but Section 25.4 already established formal plurality as a programme boundary. GRE therefore treats mathematics as one family of languages for precision rather than as the final language into which all economic inquiry should be translated.

Definition 25.81 (Selective GRE formalization). *Selective GRE formalization* is the use of a mathematically specified representation when its additional structure improves a declared analytical task sufficiently to justify the assumptions, semantic commitments, and representational losses introduced by the formalism.

Formalization follows conceptual typing. Graphs require defensible node and edge semantics; operator-like representations require meaningful transformations and types; field descriptions require discriminating distributed structure; history-bearing complexes require that the preserved historical relations matter to the question.

Formalization can nevertheless feed back into ordinary language. A failed attempt to formalize a concept may reveal ambiguity in its definition, hidden dependence on scale, inconsistent typing, or an unarticulated assumption. The failure can therefore improve GRE even when the proposed formalism is abandoned.

Proposition 25.82 (Formalization feedback principle). *The value of GRE formalization includes both successful representation and diagnostic failure: inability to formalize a concept coherently can reveal conceptual ambiguity or hidden assumptions that should be repaired independently of whether a formal model is ultimately retained.*

25.5.7 Dialogical Use

An inquiry language should also permit dialogue with scholars who do not share it. GRE would become intellectually closed if criticism first had to be translated into GRE terminology before it could count as relevant. The programme instead requires bidirectional dialogue: GRE concepts can illuminate problems in other theories, and external theories can expose redundancy, empirical weakness, conceptual inflation, missing mechanisms, or better distinctions within GRE.

Definition 25.83 (Dialogical interoperability). *Dialogical interoperability* is the capacity of the GRE inquiry language to enter structured comparison with alternative theoretical, disciplinary, empirical, and practical vocabularies without requiring those vocabularies to adopt GRE's categories as a condition of criticism or contribution.

Interoperability requires common objects of disagreement. Critics can challenge a generative attribution, relational explanation, value distinction, or domain translation without adopting GRE terminology. GRE should respond through evidence, scope revision, conceptual repair, or rejection on stated grounds rather than terminological insulation.

Dialogue also supports cumulative comparison. When two theories use different terms but make comparable predictions or mechanism claims, their disagreement can be reconstructed without forcing lexical harmonization. When they answer different questions, the dialogue can reveal complementarity rather than artificial competition.

Proposition 25.84 (Vocabulary-independent contestability). *A criticism or alternative explanation can count against a GRE claim even when it is formulated outside GRE vocabulary, provided that it addresses the same empirical, inferential, formal, or normative burden with sufficient specificity.*

25.5.8 Limits of the Inquiry Language

Treating GRE as a language of inquiry creates its own risk. A vocabulary that becomes familiar can make the distinctions it contains appear natural, while phenomena that do not fit those distinctions become harder to notice. Repeated use of words such as relation, generation, value, conversion, circulation, power, field, spacetime, or manifestation can also create an illusion of explanatory continuity even where their local meanings differ substantially.

Definition 25.85 (Inquiry-language blind spot). An *inquiry-language blind spot* is a recurrent failure to notice, describe, or test an economically relevant phenomenon because the available GRE vocabulary, question structure, or distinction set makes alternative framings difficult to express or treats them as derivative by default.

Blind spots can arise through lexical saturation, semantic expansion, inherited binaries, favored formalisms, poorly corrected imports, or the assumption that every relevant process must fit the current GRE taxonomy. They are difficult to detect when the programme is assessed only from within its own language.

Shared vocabulary remains necessary for cumulative work, but it should stay permeable to paraphrase, external description, counterexample, reclassification, and concept retirement.

Definition 25.86 (GRE language-revision trigger). A *GRE language-revision trigger* arises when recurrent empirical, comparative, cross-domain, historical, or dialogical work shows that a GRE term, distinction, or question form systematically obscures relevant alternatives, collapses materially different mechanisms, or requires semantic stretching to accommodate counterevidence.

Proposition 25.87 (Language non-mandatoriness principle). *No GRE term is mandatory for valid economic inquiry merely because it belongs to the programme; the programme should preserve conceptual identity through inferential work and explicit distinctions rather than through compulsory terminology.*

Definition 25.88 (GRE inquiry-language profile). The *GRE inquiry-language profile* is the versioned record of the programme's principal question forms, analytical distinctions, translation rules, comparison frames, reconstruction concepts, formal resources, dialogical interfaces, known blind spots, and language-revision triggers.

Proposition 25.89 (Inquiry language as revisable infrastructure). *GRE is best treated as a language of economic inquiry when its vocabulary functions as revisable research infrastructure: stable enough to support cumulative comparison, yet permeable enough to permit paraphrase, counterexample, alternative formalization, domain correction, and concept retirement.*

The language perspective adds a distinct dimension to GRE's programme identity: a structured way of making economic questions, distinctions, translations, comparisons, reconstructions, formalizations, and disagreements explicit. Its usefulness depends on improving inquiry relative to alternatives; its legitimacy depends on remaining contestable and replaceable. The following section examines how this economic inquiry language stands as a domain instantiation of preliminary Generative Relational foundations.

25.6 Economic Instantiation of Preliminary GR

Section 25.5 described GRE as a revisable language of economic inquiry. The present section locates that language within the wider Generative Relational project without reversing the book's order of warrant. GRE is the principal domain developed here; GR supplies only the preliminary foundations needed to formulate and discipline that economic programme. The objective is therefore to specify what is shared, what is economically reconstructed, what can fail locally, what may travel across domains, and what evidential burden would have to be met before any broader Generative Relational Theory (GRT) could be claimed. The section proceeds through eight issues: domain specificity, shared foundations, economic concept formation, economic failure, cross-domain learning, candidate invariants, non-transferable assumptions, and conditions for future GRT. The method is comparative and dependency-sensitive. Recurrence of vocabulary is treated as a starting point for testing, not as evidence of completed generality.

Definition 25.90 (GRE domain instantiation). A *GRE domain instantiation* is the economically specific reconstruction of preliminary Generative Relational questions, distinctions, and analytical disciplines within an economic problem-space, such that the resulting concepts remain answerable both to economic evidence and to the limits of the preliminary foundations from which they were developed.

The word *instantiation* therefore does not mean mechanical application. A domain instantiation may alter the meaning, typing, evidential burden, or usefulness of a preliminary concept. It may also reveal that a supposedly general distinction does not survive domain-specific investigation.

Proposition 25.91 (Domain-first warrant principle). A *GRE result acquires broader GR significance only after its economic warrant has been established at the level appropriate to the claim; recurrence of GR vocabulary within GRE cannot substitute for domain-specific evidence.*

Table 25.6 summarizes the eight dimensions developed below. The table is intentionally asymmetric: the first four concern what GRE receives and reconstructs, while the last four concern what GRE can return to broader comparative inquiry.

25.6.1 Economic Domain Specificity

GRE is not defined merely by attaching economic examples to relational vocabulary. Its domain specificity comes from the kinds of problems for which it seeks economic explanation: allocation, capability, value formation and conversion, circulation, property and access, institutional coordination, economic power, distribution, economic participation, intertemporal consequence, and the generation or foreclosure of economically consequential possibilities.

Definition 25.92 (GRE principal problem-space). The *GRE principal problem-space* is the set of questions concerning how economically relevant subjects, relations, capacities, institutions, value forms, constraints, conversion conditions, circulation paths, power structures, and possibility spaces are generated, sustained, transformed, allocated, or foreclosed within historically situated economic life.

The adjective *economic* remains indispensable. A relation can be politically legitimate or illegitimate, legally valid or invalid, aesthetically valuable or poor, educationally enabling or damaging, and ecologically regenerative or destructive in ways

Table 25.6: Architecture of GRE as an economic instantiation of preliminary GR foundations

Dimension		GRE task	Principal discipline
Domain specificity		Define the economic problem-space and its objects without assuming universal scope	Economic warrant precedes cross-domain generalization
Shared foundations		Reuse minimal GR questions and distinctions where they remain useful	Foundations are preliminary and revisable
Economic concepts		Develop domain-specific concepts such as allocation, value conversion, circulation, power, and economic spacetime	Domain semantics are not generic GR primitives by default
Economic failures		Record where GRE concepts fail, overreach, or require retyping	Failure can revise GRE and test supposed generality
Cross-domain learning		Compare independently developed neighboring domains	Correction is bidirectional rather than export-only
Candidate invariants		Test recurrent structures across domains and historical settings	Shared origin is a confound, not corroboration
Non-transferable assumptions		Identify assumptions that depend on economic institutions or semantics	Failed transfer is positive evidence about scope
Future GRT		Promote only structures surviving independent, adversarial comparison	General theory remains a future empirical and conceptual achievement

that GRE cannot settle by economic analysis alone. GRE enters those questions when the relevant relation also changes economic access, capability, allocation, value realization, dependence, or future possibility. It does not acquire authority over the non-economic predicate merely because economic consequences are present.

Domain specificity also prevents an opposite error: reducing economics to pre-existing markets, prices, exchange, or monetary allocation. The economic problem-space itself is historically generated. Care, knowledge, digital infrastructure, platforms, AI systems, environmental constraints, public goods, credentials, legal recognition, and symbolic forms may become economically consequential through different historical architectures. GRE therefore treats the boundary of the economic domain as revisable without treating it as unlimited.

Proposition 25.93 (Problem-space identity principle). *GRE remains an economic programme when its principal explanatory target is an economically consequential problem-space, even where the empirical object is simultaneously legal, political, social, educational, ecological, technical, or aesthetic.*

This principle is claim-specific rather than object-specific. A university, court, household, watershed, AI system, museum, firm, or state may support several domain analyses at once. GRE's task is to specify which economically relevant predicates it explains and which predicates remain under another domain's authority.

25.6.2 Shared Preliminary GR Foundations

The book has used a deliberately sparse set of preliminary GR resources. They are shared because they organize inquiry across several parts of the book, not because they have been established as universal ontology. Four minimal analytical primitives—change, structure, constraint, and difference—allow richer objects to be introduced without presupposing that subjects, relations, institutions, fields, or value forms are metaphysically primitive. The three-level reality architecture distinguishes ontological reality, whose ultimate character is suspended; relational reality, comprising sufficiently stable and causally consequential relational configurations; and manifestational reality, through which such configurations become accessible under particular conditions.

Definition 25.94 (Preliminary GR foundation set). The *preliminary GR foundation set* is the revisable collection of minimal questions and distinctions used in this book before domain-specific GRE concepts are introduced, including change, structure, constraint, difference, ontological suspension, relational reality, manifestation, historical situatedness, relational-generative analysis, and explicit revisability.

These resources are intentionally thinner than GRE itself. They do not contain an economic value theory, a theory of conversion, an account of economic circulation, a power genealogy, a justice architecture, or an economic spacetime model. Nor do they determine which methods should be used in a particular study. Their function is to make several families of questions available while keeping stronger commitments open to correction.

The term *foundation* should therefore not be read foundationalistically. Some foundations may later prove domain-bound, redundant, or badly typed. The economic domain can test them. If manifestation adds no discrimination in a class of cases, if relational priority repeatedly underperforms mixed explanations, or if the three-level architecture becomes unstable under empirical use, GRE supplies reasons to revise the preliminary GR foundation rather than merely adjust the economic application.

Proposition 25.95 (Foundation revisability principle). A *preliminary GR distinction used by GRE remains a working foundation only while it continues to improve economic inquiry relative to serious alternatives; economic failure can therefore propagate upward to revision of the preliminary foundation itself*.

This upward direction of correction is essential. Without it, calling GRE an instantiation would make GR insulated from the very domain evidence that is supposed to give its concepts content.

25.6.3 Economic Concept Formation

GRE adds substantive economic concepts that cannot be read directly from the preliminary foundation set. Relational allocation, generative value, conversion, circulation, return, capture, regeneration, economic participation, economic power, economic justice, epistemic economy, capability asymmetry, and economic spacetime each require domain-specific typing and evidential bridges.

Definition 25.96 (Domain-generated GRE concept). A *domain-generated GRE concept* is an analytical object whose meaning and evidential role arise through economic reconstruction of preliminary GR questions rather than by direct inheritance from a presumed general GR vocabulary.

This distinction matters because the word *relation*, for example, is too thin to tell us whether a particular economic mechanism is trust, dependence, ownership, authority, conversion access, bargaining asymmetry, circulation control, or institutional recognition. Likewise, a general notion of change does not distinguish generation from transfer or conversion. Economic theory has to supply those distinctions and test whether they matter empirically.

The resulting concepts may later prove portable. Value conversion might have analogues in education or law; circulation might illuminate other domains; a history-bearing relational representation may prove useful outside economics. Yet portability is a result to be tested after domain construction, not a property granted at birth.

Proposition 25.97 (Domain enrichment principle). *A domain instantiation can add conceptual structure that is absent from its preliminary foundations; successful domain construction therefore contributes potential new material to future cross-domain theory rather than merely instantiating a fixed prior scheme.*

GRE is consequently both downstream and productive. It is downstream because it inherits preliminary questions and disciplines. It is productive because economic research can generate distinctions that later become candidates for broader comparison.

25.6.4 Economic Failure as Foundation-Relevant Evidence

Chapter 24 developed an extensive account of limitation, defeat, and architectural revision. Those failure conditions acquire an additional role here. A failure can be local to GRE, but it can also reveal that a supposedly shared GR structure was badly specified.

Definition 25.98 (Domain failure signal). *A domain failure signal is a recurrent empirical, formal, conceptual, historical, or normative failure within GRE that bears on the adequacy of a preliminary GR distinction or bridge used across multiple GRE claims.*

Suppose that relational explanations repeatedly add no discrimination after strong mixed-mechanism comparisons. The immediate result is a limitation on GRE's relational claim. If the failure recurs across independent economic problem classes, however, it also counts against any broader assertion that relational priority should organize GR generally. The same logic applies to manifestation, generativity, field language, spacetime representations, or other recurring structures.

Failure signals should be typed before they are generalized. A failed value-conversion model can arise from economic institutions that do not exist elsewhere. A failed power model may reveal a problem with the economic genealogy of power rather than with a general theory of relational asymmetry. A failed formal representation may concern its parameterization rather than the underlying conceptual distinction.

Proposition 25.99 (Failure localization before generalization). *A GRE failure should first be localized to the narrowest economic claim, bridge, or concept that it defeats; only recurrent failures sharing a preliminary GR dependency justify upward revision pressure on that dependency.*

This mirrors the counterevidence discipline established earlier in the book. It also prevents one disappointing application from being treated as decisive evidence for or against a future general theory.

25.6.5 Cross-Domain Learning

A future GR programme cannot be built by exporting GRE vocabulary into neighboring fields and then counting the resulting recurrence as confirmation. Cross-domain learning requires independently constituted domains capable of correcting the proposed shared structure. History, governance, law, political theory, education, ecology, social theory, aesthetics, and AI studies each contain objects, evidence, methods, and normative authorities that are not reducible to economics.

Definition 25.100 (Cross-domain learning event). A *cross-domain learning event* occurs when comparison with an independently warranted neighboring-domain result changes the scope, semantics, evidential burden, formal representation, or revision status of a GRE concept or of a candidate shared GR structure.

Learning can be confirmatory, differentiating, or corrective. A neighboring domain may independently reconstruct a similar generative distinction, strengthening its candidacy for broader comparison. It may preserve only part of the structure, showing that the GRE concept contains domain-specific components. Or it may reject the translation altogether, revealing that the apparent commonality depended on economic assumptions.

The relevant comparison is therefore not lexical. Two domains can use the word *value* while referring to objects with different constitutive rules and normative authorities. Conversely, they can use different vocabularies while instantiating a comparable transformation structure. Cross-domain learning must compare roles, mechanisms, evidence, and correction pathways rather than words alone.

Proposition 25.101 (Independent-domain correction principle). A *neighboring domain contributes stronger evidence to broader GR development when its relevant structure is reconstructed under its own evidential and conceptual disciplines and remains capable of correcting, narrowing, or rejecting the GRE analogue.*

This is why cross-domain answerability is more valuable than superficial unification. A domain that cannot say no to a proposed generalization cannot provide independent support for it.

25.6.6 Candidate Cross-Domain Invariants

Some structures developed in GRE may eventually recur elsewhere. Relation-sensitive constitution, generative transformation, typed conversion, non-invertible manifestation, historically conditioned constraint, possibility-space change, and revision-sensitive formalization are plausible examples of structures worth comparing. At present, however, they should remain *candidate* invariants.

Definition 25.102 (Candidate GR invariant). A *candidate GR invariant* is a structural distinction, dependency, or transformation pattern that appears to survive translation across more than one independently developed domain while retaining enough semantic and inferential content to support non-trivial comparison.

Candidate invariance requires more than recurrence. The shared-origin problem is especially important. GR-influenced domains may resemble one another because researchers intentionally began from the same vocabulary, diagrams, or formal intuitions. Such *designed recurrence* is useful for programme construction but weak evidence of generality.

A stronger case arises when a domain begins from its own problem-space and,

through its own evidence and methods, arrives at a structurally similar distinction. The comparison should also survive historical variation. A structure found only in contemporary platform economies and contemporary AI governance may reflect common institutional history rather than a more general relational regularity.

Definition 25.103 (Candidate-invariant dossier). A *candidate-invariant dossier* records the domains compared, their degree of developmental independence, the translated structure, preserved and altered semantics, historical variation, failed cases, domain-specific remainders, rival explanations, and the analytical content that survives the comparison.

Proposition 25.104 (Generality-content balance). *A candidate invariant becomes theoretically useful only if increasing cross-domain scope does not strip away so much structure that the surviving claim loses discriminating analytical content.*

A statement such as “things change under constraints” may be broadly true but too thin to support a distinctive GRT. Generality and explanatory content have to be evaluated together.

25.6.7 Non-Transferable Economic Assumptions

Economic inquiry relies on assumptions and institutional facts that cannot be presumed outside economics. Property, prices, contracts, legal personhood, firms, monetary accounting, labor markets, bargaining, taxation, credit, exchange, scarcity conventions, recognized ownership, and administratively legible economic categories can be constitutive of an economic mechanism. Even where neighboring domains contain analogues, their semantics may differ materially.

Definition 25.105 (Non-transferable economic assumption). A *non-transferable economic assumption* is an assumption, institutional condition, semantic typing, measurement convention, or normative premise that materially supports a GRE result but lacks independent warrant in the receiving domain.

Non-transferability is not a defect. It identifies where GRE is genuinely economic. For example, a conversion interface defined through legally enforceable ownership and monetary pricing cannot be exported unchanged into an ecological relation whose relevant values are not constituted by those institutions. Similarly, a bargaining model presupposing substitutable agents and credible exit may fail in kinship, ecological stewardship, or legal status relations where exit and substitution have different meanings.

Definition 25.106 (Domain-specific remainder of GRE transfer). The *domain-specific remainder of GRE transfer* is the set of economic assumptions, institutional dependencies, semantic distinctions, and evidential bridges that must be dropped, retyped, or replaced when a GRE concept is reconstructed elsewhere.

Failed transfer can therefore improve theory. It identifies which components belonged to economic history or institutions rather than to a more general relational structure.

Proposition 25.107 (Non-transfer as positive evidence). *A well-diagnosed failure of GRE transfer provides positive evidence about programme scope by revealing which assumptions are economically constitutive and which candidate structures survive their removal.*

25.6.8 Conditions for Future General Relational Theory

The possibility of a future GRT remains open, but this book does not claim to have completed it. A general theory worthy of the name would require more than the recurrence of GR vocabulary in domains that share a common intellectual ancestry. It would need independently developed domain inquiries, historically varied cases, explicit translation and non-translation, adversarial testing, preservation of domain-specific remainders, and a clear account of what analytical content remains after generalization.

Definition 25.108 (Future-GRT evidential threshold). The *future-GRT evidential threshold* is the minimum comparative burden required before a structure developed within one or more GR domains is promoted into a provisional general-theory claim: independent domain reconstruction, semantic typing, historical variation, serious counterexamples, failed-transfer records, rival explanations, correction authority, and sufficient surviving analytical content.

The threshold is modular. Different candidate structures may mature at different rates. A general manifestation distinction might receive stronger comparative support than a general theory of value; a cross-domain account of historical constraint might mature independently of any general formalism. GRT need not emerge as one simultaneous deductive system.

Future generalization should also preserve downward correction. If a GRT candidate later conflicts with well-supported economic, legal, ecological, educational, or other domain evidence, the general statement must be revisable. The purpose of a general theory is not to outrank its domains but to organize structures that survive their mutual correction.

Definition 25.109 (Domain-return condition). The *domain-return condition* requires any provisional GRT claim to remain interpretable within, testable against, and revisable by the independently warranted domain inquiries from which its comparative support was derived.

Proposition 25.110 (Emergent general-theory principle). *A future GRT should be treated as an emergent comparative achievement of sufficiently independent domain research rather than as a template whose prior authority is established by repeated application of the same vocabulary.*

Definition 25.111 (GRE-to-GRT contribution profile). The *GRE-to-GRT contribution profile* is the versioned record of preliminary GR foundations used by GRE, economic concepts developed beyond those foundations, domain failures bearing on shared structures, candidate invariants, non-transferable economic assumptions, cross-domain corrections, and general-theory claims that GRE can presently support, challenge, or leave open.

Proposition 25.112 (Economic instantiation without premature unification). *GRE can be a substantive economic instantiation of preliminary Generative Relational foundations while remaining logically compatible with multiple future outcomes: confirmation of some cross-domain structures, decomposition of others, regionalized theories, competing GR families, or no single sufficiently contentful GRT.*

The domain-instantiation perspective therefore gives GRE a two-way relation to the wider Generative Relational project. Preliminary GR resources help organize economic inquiry, but economics returns domain-specific concepts, failures, counterexamples, and candidate structures that can revise those resources. The result is not a

hierarchy in which a finished GR governs its applications. It is a recursive research architecture in which domains develop enough independence to make comparison informative. The next section applies the same discipline temporally by examining the historical revisability of GRE itself.

25.7 Historical Revisability of GRE

Section 25.6 located GRE within a recursive relation between economic inquiry and preliminary Generative Relational foundations. The present section applies the same discipline to GRE across time. A historically situated research programme cannot treat its current vocabulary, methods, evidence base, normative premises, or domain boundary as if they were produced outside history. The objective is therefore to specify how GRE can change historically without reducing revision to either ordinary error correction or unrestricted reinterpretation. The section proceeds through eight issues: the historical position of theory, concept revision, method revision, evidential reassessment, normative revision, domain revision, versioned theory, and reconstructable theoretical history. The method is genealogical and dependency-sensitive. A later formulation is treated as a successor to an earlier one only when the relevant continuities, revisions, reasons, and consequences can be reconstructed.

Definition 25.113 (Historical revisability of GRE). *Historical revisability of GRE* is the programme-level condition under which GRE's claims, concepts, methods, evidential warrants, normative commitments, domain boundaries, and internal dependencies may be revised as historical circumstances and available knowledge change, while the reasons, scope, and consequences of those revisions remain reconstructable.

Historical revisability is stronger than admitting that later researchers may know more. A theory can remain empirically accurate in one period while its categories become less discriminating in another; a method can remain technically valid while new infrastructures alter what it measures; a normative premise can remain internally coherent while new affected positions make its scope incomplete. Revision can therefore concern meaning, relevance, evidence, or domain constitution as well as truth or falsity.

Proposition 25.114 (Historically indexed programme identity). *GRE should be identified through a reconstructable sequence of historically indexed programme states rather than through the fiction of one timeless formulation whose current vocabulary retrospectively governs every earlier or later version.*

Table 25.7 summarizes the principal revision dimensions developed below.

25.7.1 Historical Position of Theory

A theory is produced from a historical position. The problems regarded as economically important, the data available for observing them, the institutions through which economic life is organized, and the neighboring disciplines with which economics interacts are historically variable. GRE cannot escape that condition by describing itself as relational or generative. Its own attentional priorities were formed in response to a particular intellectual and socio-technical environment.

Historical situatedness does not make a theory merely relative to its moment. It instead requires the programme to distinguish what is expected to travel from

Table 25.7: Principal dimensions of historical revisability in GRE

Revision dimension	Possible historical change	Required record
Theory position	Problems, institutions, technologies, and available comparisons change	Historical position and validity horizon
Concepts	Meanings, boundaries, and type distinctions shift	Concept genealogy and semantic bridge
Methods	New methods or changed objects alter inferential adequacy	Method substitution and comparability record
Evidence	New archives, measurements, or reinterpretations alter warrant	Evidential supersession record
Normative premises	Standing, values, priorities, or affected positions change	Normative provenance and revision reason
Domain boundary	Economic relevance or neighboring-domain jurisdiction changes	Boundary genealogy and correction authority
Programme version	Several revisions accumulate into a new configuration	Version dependency map
Research memory	Earlier claims, failures, and alternatives risk being lost	Reconstructable revision history

what depends on historically specific conditions. A relational account of platform dependence, for example, may preserve an analytical structure across technological regimes while the relevant actors, infrastructures, contractual arrangements, and verification capacities change substantially.

Definition 25.115 (GRE historical position profile). A *GRE historical position profile* records the principal economic problems, institutional forms, technologies, data infrastructures, disciplinary interfaces, normative disputes, and known blind spots that materially shape a GRE formulation at a given historical stage.

The profile is not biographical context. Its function is analytical: it identifies background conditions that may have entered the programme's categories or evidential expectations. A later researcher can then ask whether a claim remains warranted because its mechanism survives changed conditions or merely because inherited vocabulary continued to be used.

Definition 25.116 (Theoretical validity horizon). A *theoretical validity horizon* is the set of historically specified conditions within which a claim, concept, method, or formal representation is presently expected to retain its intended semantics and evidential warrant without material revalidation.

The horizon can be broad or narrow. It should not be confused with an expiration date. A concept may remain useful well beyond its original setting, but historical change creates a reason to test rather than presume continuity.

Proposition 25.117 (Historical revalidation principle). *When institutions, technologies, subject positions, categories, or evidence-generating processes change materially relative to a GRE claim's stated validity horizon, continued use of that claim should require historical revalidation rather than semantic continuity by default.*

25.7.2 Concept Revision

GRE's central concepts are working analytical constructions. Relation, subject, value, generation, conversion, circulation, power, manifestation, participation, field, and spacetime can all acquire different empirical content as economic forms change. Historical revision therefore cannot be documented adequately by keeping the same label while silently changing its meaning.

Concept revision can take several forms. A category can be narrowed when recurrent cases previously grouped together prove mechanistically distinct. It can be subdivided when one category contains several independently consequential types. It can be merged when distinctions add no analytical discrimination. It can be regionalized when a concept is useful only in a specified historical or institutional regime. It can be retyped when its inferential role changes. It can also be retired.

Definition 25.118 (GRE concept genealogy). A *GRE concept genealogy* is the versioned record of a concept's meanings, scope conditions, type distinctions, empirical motivations, formal representations, revisions, competing formulations, and reasons for retention, subdivision, merger, regionalization, retyping, or retirement.

A genealogy should preserve both continuity and discontinuity. If a later version of *power* adds conversion-rule control or infrastructural dependence, it should be possible to determine whether the concept has been enriched, partially replaced, or used for a materially different analytical object.

Definition 25.119 (Semantic succession bridge). A *semantic succession bridge* specifies which meanings and inferential roles of a concept are preserved between two programme versions, which are changed, and which earlier claims require reinterpretation because of the change.

Proposition 25.120 (Concept-continuity burden). *Reuse of the same GRE term across programme versions does not establish conceptual continuity; continuity should be claimed only where a semantic succession bridge preserves the dimensions required for the relevant comparison or inference.*

This discipline also protects earlier work from retrospective assimilation. A later, more elaborate concept should not be projected backward into an earlier paper or chapter unless the earlier object and warrant actually support that reconstruction.

25.7.3 Method Revision

Methods change historically because both research technologies and research objects change. Archival digitization can alter historical coverage; computational methods can make previously inaccessible relational structures observable; new experimental or quasi-experimental opportunities can strengthen causal discrimination; qualitative access can reveal mechanisms hidden by aggregate measurement. At the same time, new methods create new representation errors, dependencies, and blind spots.

GRE's methodological pluralism therefore has a temporal dimension. A method justified in one programme version need not remain privileged when a later method answers the same inferential question with greater discrimination or fewer unsupported assumptions. Conversely, novelty does not automatically establish superiority.

Definition 25.121 (Method succession record). A *method succession record* documents why a GRE study or programme component changes its principal method,

which inferential burden the new method addresses, which earlier results remain comparable, which become non-comparable, and which new assumptions or representation limits the replacement introduces.

Method revision can create a comparability problem. If a new relational measurement changes node definitions, time resolution, or observation rules, a difference between old and new results may reflect the method rather than the economic process. Historical continuity of evidence therefore requires explicit bridges between measurement regimes.

Definition 25.122 (Method-comparability bridge). A *method-comparability bridge* states the transformations, preserved observables, changed assumptions, and residual differences required to compare results produced by different methodological regimes.

Proposition 25.123 (Method revision without retrospective invalidation). *Adoption of a method with stronger present inferential adequacy does not by itself invalidate earlier GRE work; earlier claims should be reassessed according to the evidence and methods available to them, then re-evaluated separately under the later method where comparison is possible.*

The proposition preserves historical fairness without granting immunity to inherited claims. Later methods can substantially weaken earlier conclusions while still distinguishing reasonable earlier inference from present warrant.

25.7.4 Evidential Reassessment

Evidence changes even when the past does not. New archives can be opened, records can be digitized, datasets can be linked, measurement errors can be discovered, synthetic artifacts can contaminate evidence environments, and new theories can change what counts as a discriminating observation. Evidence is therefore historically revisable in both availability and interpretation.

GRE should distinguish additional evidence from evidential supersession. More observations may simply increase coverage. Supersession occurs when later evidence materially changes the warrant of an earlier claim by exposing a measurement defect, revealing a previously hidden mechanism, enabling stronger rival discrimination, or changing the interpretation of the earlier evidence.

Definition 25.124 (Evidential supersession event). An *evidential supersession event* occurs when newly available, newly interpretable, or newly validated evidence materially changes the warranted status of an existing GRE claim rather than merely adding another observation to the same evidential base.

Supersession need not produce simple reversal. An earlier broad claim may survive only in a narrower subgroup; a causal claim may become descriptive; a historical reconstruction may become one member of a larger compatibility class; a qualitative mechanism may receive stronger support even while its prevalence estimate changes.

Definition 25.125 (Evidential revision ledger). An *evidential revision ledger* records the prior claim, prior evidence, new evidence or interpretation, changed inferential bridge, revised claim status, residual uncertainty, and downstream GRE components affected by the reassessment.

Proposition 25.126 (Non-retroactive evidence discipline). *Later evidence should revise the present warrant of earlier GRE claims without being treated as evidence that*

earlier researchers possessed, ignored, or should necessarily have anticipated information that was not reasonably available within their historical epistemic horizon.

This is the programme-level counterpart of the historical epistemic discipline developed earlier in the book. A reconstructable theory history should preserve both present judgment and historical epistemic position.

25.7.5 Normative Revision

GRE's normative restraint does not remove normative history. Standing rules, conceptions of harm, acceptable risk, intergenerational concern, ecological obligations, participation standards, and judgments about coercion or recognition can change. Some changes reflect moral learning; others reflect shifts in power, institutional settlement, or social convention. GRE should therefore neither freeze current normative premises nor presume that later normative frameworks are automatically superior.

Normative revision requires provenance. A later evaluation may change because new affected positions become visible, because an empirical premise was corrected, because a normative framework was revised, or because institutional authority changed. These are analytically different.

Definition 25.127 (Normative revision profile). *A normative revision profile* records the evaluative claim being revised, the standing rules, values, thresholds, priorities, rights, procedural commitments, or intergenerational premises involved, the reason for revision, the relevant authority or argument, and the GRE conclusions whose normative status changes as a result.

A historical revision can also expose earlier normative omission. An economic analysis may have treated unpaid care, ecological damage, disabled access, future generations, or non-human affectedness as outside its evaluative frame. Later inclusion should be recorded as expansion of standing or scope, not presented as if the earlier framework had already contained the same subjects implicitly.

Definition 25.128 (Normative standing revision). *A normative standing revision* occurs when the set of subjects, positions, interests, relations, or future claims treated as normatively relevant is materially expanded, narrowed, or retyped within a GRE evaluation.

Proposition 25.129 (Normative revision transparency). *When a GRE recommendation changes because its normative premises or standing rules have changed, the revision should be identified as normative rather than represented as though new empirical evidence alone compelled the later evaluation.*

This transparency is especially important in a framework committed to normative underdetermination. Historical change can alter the normative bridge without altering the underlying empirical mechanism.

25.7.6 Domain Revision

The economic domain itself is historically revisable. Activities once organized primarily through households, communities, public institutions, professional norms, or informal relations can become monetized, platform-mediated, regulated, financialized, automated, or newly measured. Conversely, formerly market-mediated activities can move into public provision, commons arrangements, or non-market coordi-

nation. Such changes alter which predicates become economically consequential and which neighboring-domain interfaces matter.

Domain revision should not be confused with unlimited expansion. GRE does not become competent to settle legal validity, political legitimacy, ecological value, educational quality, or technical truth merely because those matters become economically consequential. Historical change can enlarge or reorganize the economic problem-space while correction authority remains distributed across domains.

Definition 25.130 (Economic-domain boundary genealogy). An *economic-domain boundary genealogy* records how a class of objects, relations, activities, or claims entered, exited, or changed position within GRE's principal economic problem-space, together with the institutional changes, evidential reasons, and neighboring-domain dependencies supporting that reclassification.

The boundary can also contract. A concept introduced as broadly economic may later prove mainly legal, political, ecological, educational, or technical once its constitutive mechanism is better understood. Domain revision must therefore support both inclusion and deference.

Definition 25.131 (Domain reclassification event). A *domain reclassification event* occurs when a claim or object previously treated as directly within GRE is reassigned to partial GRE explanation, domain deference, or another principal disciplinary jurisdiction, or when a previously external phenomenon becomes economically constitutive enough to require direct GRE analysis.

Proposition 25.132 (Historically revisable domain identity). *GRE can retain a recognizable economic identity while the historically constituted boundary of its principal problem-space changes, provided claim-specific jurisdiction, external correction authority, and reasons for reclassification remain explicit.*

25.7.7 Versioned Theory

Once concept, method, evidence, normative, and domain revision are admitted, a theory should not be represented as one continuously overwritten text. Later changes can alter the meaning of earlier claims, remove assumptions on which other components depended, or create branches that should remain simultaneously available for comparison. GRE therefore requires explicit versioning at the level of programme architecture as well as manuscripts and datasets.

Definition 25.133 (GRE programme version). A *GRE programme version* is a historically indexed configuration of claims, concepts, methods, formal representations, evidential warrants, normative premises, domain boundaries, open problems, and dependency relations that is sufficiently specified to be compared with earlier and later configurations.

Versioning should not imply that every minor editorial change creates a new theory. The relevant threshold is conceptual or inferential: a new version is warranted when a change materially alters the semantics, scope, warrant, dependency, or revision consequence of a substantive component.

Definition 25.134 (Programme-version transition). A *programme-version transition* is the documented transformation connecting two GRE programme versions through retained components, revised components, retired components, newly introduced components, changed dependencies, and explicit reasons for the transition.

Versions can also branch. Competing formalisms or value theories need not be forced into one successor if the evidence does not yet discriminate among them. Section 576 will treat such plural formulations directly. Historical versioning provides the infrastructure required to preserve them without losing programme identity.

Proposition 25.135 (Non-erasure versioning principle). *Revision of GRE should preserve the recoverability of superseded programme states, including claims and formulations no longer endorsed, whenever their history is materially relevant to understanding present concepts, evidence, dependencies, or unresolved alternatives.*

25.7.8 Reconstructable Theoretical History

Historical revisability becomes intellectually useful only if later researchers can reconstruct why the theory changed. A final document that retains only current conclusions erases failed hypotheses, abandoned categories, negative results, disputes, evidential reversals, and alternative branches that may explain how the programme reached its present form. Such erasure weakens both accountability and future re-analysis.

Definition 25.136 (Reconstructable theoretical history). *A reconstructable theoretical history is a provenance-preserving record from which a later researcher can recover the principal programme versions, their substantive differences, the evidence and arguments motivating transitions, competing alternatives, negative results, domain corrections, normative changes, and consequences for downstream claims.*

Reconstructability does not require preserving every draft. It requires preserving enough information to understand substantive change. A useful record should identify the pre-revision state, trigger, considered alternatives, decision or branching point, affected dependencies, validation performed, and unresolved remainder.

Definition 25.137 (Theory-revision provenance record). *A theory-revision provenance record links a substantive GRE revision to its triggering evidence or argument, responsible programme components, considered alternatives, resulting version transition, affected claims, and residual uncertainties or disagreements.*

The record also protects later interpretation from inevitability narratives. Once a revision appears successful, earlier alternatives can look obviously mistaken. Preserving the decision context reveals which alternatives were reasonable, which evidence was decisive, and which outcomes remained uncertain at the time.

Proposition 25.138 (Reconstructability as revision discipline). *A GRE revision is epistemically stronger when a later researcher can reconstruct not only the resulting formulation but also the evidential, conceptual, methodological, normative, or domain reasons by which the programme moved from the earlier state to the later one.*

Definition 25.139 (GRE historical revision dossier). *The GRE historical revision dossier is the integrated, versioned record of historical position profiles, concept genealogies, method succession records, evidential revision ledgers, normative revision profiles, domain boundary genealogies, programme-version transitions, and theory-revision provenance records needed to reconstruct the evolution of the programme.*

Proposition 25.140 (Historically revisable continuity principle). *GRE can remain recognizably continuous across substantial historical revision when the dependencies connecting programme versions are reconstructable; continuity therefore depends less on*

retaining identical vocabulary than on preserving an intelligible lineage of questions, warrants, revisions, and correction pathways.

Historical revisability gives the programme a temporal form of openness. GRE need not choose between doctrinal continuity and theoretical amnesia. It can preserve earlier programme states, identify why concepts or methods changed, distinguish present warrant from historical warrant, and permit revisions of normative and domain assumptions without rewriting their histories as inevitable. This versioned continuity also creates the conditions for principled internal plurality: once alternative formulations can be located historically and their dependencies made explicit, disagreement need not be resolved by forcing all variants into one supposedly final expression. The next section therefore examines how competing formulations can coexist within a recognizable GRE programme.

25.8 Plural Formulations of GRE

Section 25.7 established that GRE should possess a reconstructable theoretical history rather than one continuously overwritten formulation. The present section adds a second dimension of openness: plurality within the same historical programme state. A research programme can remain recognizable even when its investigators disagree about formalization, ontology, value, power, justice, or historical reconstruction, provided those disagreements are explicit enough to be compared and tested. The objective is therefore not to celebrate plurality in the abstract, but to distinguish legitimate internal alternatives from semantic drift, false equivalence, and formulations that revise a present core commitment so substantially that they should be treated as successor candidates rather than ordinary variants. The section proceeds through six families of competing formulation, productive internal disagreement, and conditions of programme identity. Its method is comparative and dependency-sensitive: formulations are compared by the questions they preserve, commitments they accept or revise, inferential burdens they carry, evidence that could discriminate among them, and consequences for downstream claims.

Definition 25.141 (GRE formulation). A *GRE formulation* is a sufficiently specified configuration of concepts, assumptions, methods, formal representations, evidential bridges, normative premises, and domain commitments used to investigate a GRE problem while remaining comparable with alternative configurations addressing materially related questions.

A formulation can differ locally or extensively. Two studies may share the same value theory but use different formal representations; alternatively, they may disagree about ontology, power, or justice while retaining enough common problem structure for comparison. Programme plurality therefore requires typed disagreement rather than a declaration that every version is simply “another GRE.”

Definition 25.142 (Formulation-comparison profile). A *formulation-comparison profile* records, for two or more GRE formulations, their shared research object, differing assumptions, preserved core commitments, revised commitments, empirical or interpretive consequences, discriminating evidence, unresolved remainder, and implications for programme identity.

Table 25.8 summarizes the principal forms of plurality developed below. The table does not rank the formulations. Its purpose is to identify what would make disagree-

Table 25.8: Principal forms of plurality within the GRE research programme

Formulation family	Legitimate source of plurality	Primary discipline
Formal	Different representations preserve different structures or support different inferences	Compare semantics, assumptions, empirical bridges, and lost information
Ontological	Several readings remain compatible with ontological suspension and available evidence	Do not convert representational usefulness into metaphysical settlement
Value	Alternative taxonomies or theories preserve different evaluative distinctions	Keep standing, comparison, conversion, and normative warrants explicit
Power	Different typed mechanisms explain different forms of consequential conditioning	Preserve direction, capacity, mechanism, scope, and counterevidence
Justice	Competing normative frameworks evaluate the same GRE structure differently	Separate empirical description from independent normative premises
Historical	Several reconstructions remain compatible with incomplete or contested evidence	Preserve alternative histories, category change, and discriminating evidence
Programme-level	Formulations disagree while retaining enough shared identity for common testing	State which core commitments are retained, revised, or challenged

ment analytically productive rather than merely terminological.

25.8.1 Competing Formalizations

GRE has already used graphs, temporal networks, field language, spacetime representations, 2-complexes, operator-like constructions, category-theoretic diagrams, dynamical systems language, and other formal devices. None of these should become the mandatory mathematical form of the programme merely because it proved useful in one part of the book. Different formalisms can preserve different aspects of the same economic object and therefore support different legitimate inquiries.

Definition 25.143 (Formalization plurality). *Formalization plurality* is the coexistence of two or more mathematically distinct representations of materially related GRE objects or mechanisms where each representation has explicit local semantics, preserves a defensible subset of relevant structure, and exposes its own assumptions and losses.

The criterion is not mathematical elegance alone. A network representation may preserve adjacency and path structure while obscuring higher-order relations; a 2-complex may preserve histories and compositional structure while requiring stronger representational assumptions; a dynamical model may clarify temporal dependence while imposing closure or state-space assumptions that a historical reconstruction should not accept. These models can be mutually informative without being reducible to one another.

Definition 25.144 (Formal non-equivalence remainder). A *formal non-equivalence*

remainder is the economically or inferentially relevant structure preserved by one GRE formalization but not recoverable from another under the proposed translation between them.

A stronger formalism does not automatically supersede a weaker one. Added mathematical structure is useful only when its extra assumptions and semantics earn additional analytical or empirical discrimination. Conversely, a simpler model should not be preferred merely because it is simpler if it deletes the historical or relational structure necessary for the target question.

Proposition 25.145 (Plural-formalism discipline). *Competing GRE formalizations can coexist when their semantics, preserved structures, assumptions, and non-equivalence remainders are explicit; disagreement among formalisms should be resolved only to the extent that the target inference or evidence discriminates among them.*

25.8.2 Competing Ontological Readings

Ontological plurality is more constrained. The book's default is ontological suspension, not a menu of equally established metaphysical doctrines. Researchers may interpret relational reality through stronger realist, pragmatist, processual, structural, dispositional, or other metaphysical readings, but those readings should remain distinguished from what GRE itself requires for economic inquiry.

Definition 25.146 (Ontological reading profile). An *ontological reading profile* states the metaphysical commitments a GRE formulation adds beyond ontological suspension, the economic inferences claimed to depend on those commitments, the evidence or argument offered for them, and the conclusions that remain valid if the stronger reading is withdrawn.

This profile prevents two opposite errors. Ontological suspension should not be used to prohibit legitimate metaphysical argument, but a metaphysical interpretation should not acquire programme-wide authority simply because it can redescribe GRE terminology. A relational realist and a pragmatically oriented researcher may agree on the same empirical relational mechanism while disagreeing about its ultimate ontological status.

Definition 25.147 (Ontological surplus). *Ontological surplus* is the portion of a formulation's metaphysical interpretation that exceeds what is required to support the GRE claim presently under investigation.

Ontological surplus is not automatically a defect. It can generate new hypotheses or philosophical inquiry. It becomes problematic only when conclusions requiring that surplus are presented as though they followed from the shared GRE framework itself.

Proposition 25.148 (Ontological plurality under suspension). *GRE can host competing ontological readings when the programme-level claims remain distinguishable from reading-specific metaphysical conclusions and when withdrawal of a stronger ontology does not silently remove evidential support from claims presented as generally GRE.*

25.8.3 Competing Value Theories

Value plurality within GRE has two levels. At the descriptive level, researchers can disagree about how many value forms should be distinguished, which boundaries

are useful, and whether some forms should be merged or subdivided. At the normative level, researchers can disagree about what has intrinsic, relational, instrumental, generative, ecological, educational, political, or other value and about how conflicts among these values should be evaluated.

Definition 25.149 (GRE value formulation). A *GRE value formulation* is a specified account of value-bearing objects or relations, value forms, standing rules, comparison conditions, conversion assumptions, temporal horizons, normative warrants, and residual value that guides a particular GRE inquiry.

Several value formulations can therefore share the commitment to value plurality while disagreeing substantially about the taxonomy. One formulation may treat capability and relational continuity as distinct value forms; another may reconstruct them as dimensions of a broader value family. The disagreement is productive only if each formulation states what empirical or normative distinctions its taxonomy preserves and what would be lost under the alternative.

Definition 25.150 (Value-theory discrimination burden). The *value-theory discrimination burden* is the requirement that competing GRE value formulations identify the empirical, interpretive, comparative, conversion, or normative consequences by which their different classifications or warrants could matter to inquiry.

A taxonomy that produces no difference in observation, explanation, comparison, practical judgment, or revision may be terminologically distinct without being theoretically distinct. Conversely, practical disagreement over compensation, restoration, participation, or future burden can reveal that apparently similar taxonomies hide materially different value theories.

Proposition 25.151 (Plural value-theory principle). *GRE's commitment to heterogeneous value permits competing value formulations, but it does not imply that all taxonomies are equally adequate; formulations remain answerable to the distinctions they preserve, the warrants they require, and the remainders they leave unrepresented.*

25.8.4 Competing Power Theories

Power provides another legitimate site of internal plurality. The book has developed power through typed asymmetry, credible capacity, consequential relational conditioning, control over conversion and circulation, recognition, infrastructure, information, timing, exit, and other mechanisms. Researchers may disagree about which mechanisms are primary, how much counterfactual capacity is required, or whether particular forms belong within one power family.

Definition 25.152 (GRE power formulation). A *GRE power formulation* specifies the relevant asymmetry or dependency, direction of conditioning, credible capacity, operative mechanism, affected possibilities, temporal horizon, scope, rival explanations, and conditions under which the proposed relation should cease to count as power.

Plurality is preferable to premature scalarization. Resource power, recognition power, temporal power, conversion-rule power, infrastructural power, or epistemic power may interact without becoming quantities of one common substance. A formulation that emphasizes control can therefore coexist with another emphasizing dependence or modal capacity if their differing predictions and classification rules remain visible.

Definition 25.153 (Power-formulation divergence). *Power-formulation divergence*

occurs when two GRE power theories assign different power status, mechanism type, direction, persistence, or practical consequence to the same relational configuration under otherwise materially comparable evidence.

Such divergence is useful because it creates a target for discrimination. The appropriate response is not necessarily to collapse the theories into a broader definition. Evidence may show that one captures the mechanism better, that each applies to a different scope, or that both should be retained as typed power families.

Proposition 25.154 (Typed power plurality). *Competing GRE power formulations can coexist when they preserve a shared minimal burden of directional, consequential, relational conditioning while keeping their mechanism-specific criteria and defeat conditions explicit.*

25.8.5 Competing Justice Theories

Justice plurality is necessarily normative. GRE can describe distributions, relations, recognition, participation, generative effects, conversion interfaces, intergenerational burdens, and residual value in considerable detail, but these descriptions do not uniquely determine the normative principles by which justice should be assessed. Different serious frameworks can therefore evaluate the same GRE reconstruction differently.

Definition 25.155 (GRE justice formulation). *A GRE justice formulation combines a specified empirical GRE description with explicit normative premises concerning standing, baseline, rights, duties, thresholds, priorities, aggregation, procedure, responsibility, temporal scope, and acceptable residual burdens.*

The empirical side of the formulation remains jointly contestable. If two justice theories disagree because they use different factual descriptions, stronger economic or historical evidence may narrow the disagreement. If they agree on the facts but differ in normative premises, GRE should identify the divergence rather than conceal it in a supposedly neutral metric.

Definition 25.156 (Justice-formulation convergence). *Justice-formulation convergence is agreement among materially different normative formulations on a practical or evaluative conclusion despite their distinct normative premises and reasoning paths.*

Convergence can strengthen the robustness of a recommendation within the compared set of frameworks without establishing universal moral truth. Divergence can likewise be informative by showing where empirical clarification ends and normative judgment begins.

Proposition 25.157 (Justice plurality with normative provenance). *GRE can support competing justice formulations when their empirical premises and normative warrants remain separately traceable; programme openness does not authorize hiding normative disagreement inside economic description or formal optimization.*

25.8.6 Competing Historical Models

Historical plurality differs from a simple plurality of stories. In many cases the available archives, manifestations, categories, and causal traces support more than one serious reconstruction. Different historical models may emphasize institutions, re-

lations, technologies, legal classifications, political events, ecological constraints, or economic mechanisms while remaining compatible with substantial portions of the same evidence.

Definition 25.158 (Historical-model portfolio). *A historical-model portfolio* is a documented set of serious alternative reconstructions of a GRE-relevant historical process, together with their shared evidence, differing assumptions, category bridges, causal mechanisms, missing evidence, discriminating observations, and downstream theoretical consequences.

The portfolio prevents premature closure. A later successful institution should not make its antecedent pathway appear inevitable; a surviving archive should not erase historically consequential positions that left weaker records; and one periodization should not automatically define the temporal scale of every mechanism.

Definition 25.159 (Historically discriminating evidence). *Historically discriminating evidence* is evidence whose expected interpretation differs materially across serious historical models and can therefore alter their relative warrant rather than merely adding detail shared by all of them.

Historical plurality can persist even after extensive research. That persistence is not necessarily theoretical weakness if the remaining alternatives are explicit and if conclusions are restricted to properties stable across them. It becomes problematic when the programme selects one reconstruction because it fits a preferred theory rather than because the evidence discriminates in its favor.

Proposition 25.160 (Reconstruction-plurality principle). *GRE should retain multiple historical models when available evidence does not justify unique reconstruction, while distinguishing conclusions robust across the portfolio from conclusions dependent on a particular historical interpretation.*

25.8.7 Productive Internal Disagreement

Plurality contributes to a research programme only when disagreement can do analytical work. Disagreement can reveal hidden assumptions, produce discriminating tests, identify semantic ambiguities, expose domain dependence, generate new evidence, or show that one programme component should branch. A proliferation of formulations that cannot be compared or corrected is not productive pluralism.

Definition 25.161 (Productive internal disagreement). *Productive internal disagreement* is a programme-internal divergence whose competing formulations share enough problem structure for meaningful comparison and whose differences generate identifiable empirical, interpretive, formal, normative, or scope consequences capable of guiding further inquiry.

Productive disagreement requires more than politeness toward alternatives. Competing formulations should state where they disagree, why the disagreement matters, what evidence or argument could change their relative warrant, and which downstream claims would be affected. The status ledger developed in Section 25.2 remains essential: a hypothesis and a formal representation should not be treated as rival claims merely because they use different language.

Definition 25.162 (False pluralism). *False pluralism* is the appearance of programme openness created by retaining multiple formulations whose differences are not semantically specified, not inferentially consequential, not open to discrimination, or

protected from criticism by shifting their meanings when challenged.

False pluralism can also arise when mutually inconsistent claims are declared complementary without specifying the scopes in which each is warranted. Genuine plurality permits contradiction to remain visible where it exists.

Definition 25.163 (Formulation branch point). A *formulation branch point* is a documented programme state at which materially different formulations remain sufficiently warranted to continue as separate lines of inquiry because available evidence or argument does not yet justify convergence, replacement, or retirement.

Proposition 25.164 (Disagreement-to-inquiry principle). *Internal disagreement strengthens GRE when it is converted into explicit contrasts, evidence requirements, revision conditions, or branch points; disagreement that cannot affect inquiry should not be presented as substantive programme plurality.*

25.8.8 Conditions of Programme Identity

The final issue is how much plurality GRE can sustain before programme identity becomes indeterminate. Section 25.3 identified a present identity kernel composed of relational and generative attention, historical situatedness, value plurality, revisability, methodological pluralism, praxis orientation, domain specificity, and openness to counterevidence. Plural formulations need not instantiate these commitments identically, but an ordinary programme-internal formulation should preserve enough of their joint function to remain part of current GRE.

Definition 25.165 (Programme-internal formulation). A *programme-internal formulation* is a GRE formulation that preserves the characteristic problem-space, answerability, domain discipline, and sufficient portion of the current programme identity kernel for its disagreements with other GRE formulations to remain intelligible as internal disagreements rather than as disputes between different research programmes.

This definition is intentionally functional rather than textual. A formulation can reject a particular formalism, revise a value taxonomy, or reinterpret power without leaving GRE. Even a present core commitment can be challenged. The difference is that a formulation rejecting a core commitment may no longer be an ordinary internal variant if the rejection restructures the programme's identity architecture.

Definition 25.166 (Revisionary successor candidate). A *revisionary successor candidate* is a formulation that arises from GRE's questions and evidence but proposes a sufficiently consequential revision of one or more present core commitments that its relation to current GRE should be treated as a possible programme transition rather than assumed programme-internal equivalence.

The category prevents two errors. A programme should not expel every deep criticism merely because it challenges present identity. It also should not preserve identity by definition when the revision would transform the programme's central questions, evidential discipline, domain boundary, or account of counterevidence. Section 25.7's versioned theory architecture provides the appropriate temporal relation: a revisionary successor can become a later GRE programme version if its transition is justified and reconstructable.

Definition 25.167 (Programme-identity comparison). A *programme-identity comparison* evaluates a formulation against the current GRE problem-space, core commit-

ments, commitment boundaries, epistemic-status discipline, domain identity, and defeat/revision pathways, recording which elements are retained, revised, rejected, or replaced.

Proposition 25.168 (Plurality-with-identity principle). *GRE can sustain substantial internal plurality when formulations remain mutually contestable and preserve enough shared programme structure for comparison; fundamental revision should instead be recorded as a possible programme transition.*

Plurality therefore locates coherence in reconstructable relations among alternatives rather than in one compulsory formalism, ontology, value theory, power model, justice theory, or historical reconstruction. The next section turns this internal contestability outward by examining the collaborative conditions through which criticism, counterexamples, replication, reinterpretation, and cross-disciplinary participation can become effective parts of the programme.

25.9 Collaboration and Contestability

Section 25.8 established that GRE can sustain plural formulations when disagreements remain explicit enough for comparison and when consequential departures from the present identity kernel are recorded as possible programme transitions. The present section specifies the social and epistemic conditions under which such plurality becomes answerable. A research programme remains revisable only when criticism can reach identifiable claims, counterexamples can alter scope or warrant, replication can test dependence on particular evidence or procedures, reinterpretation can reopen inferential bridges, and collaborators beyond the originating research setting can exercise meaningful correction. The objective is therefore to construct contestability as a programme mechanism rather than as a general declaration of openness. The section proceeds through criticism, counterexamples, replication, reinterpretation, cross-disciplinary and cross-cultural collaboration, public contestability, and institutional contestability. Its method is dependency-sensitive and role-sensitive: each challenge is evaluated by its target, epistemic standing, correction authority, evidential basis, downstream consequences, and preservation requirements.

Definition 25.169 (GRE programme contestability). *GRE programme contestability* is the condition under which materially consequential claims, concepts, methods, formal representations, evidential bridges, normative premises, domain classifications, and applications can be challenged through identifiable procedures whose possible consequences for warrant, scope, revision, branching, or retirement are explicitly recorded.

Contestability therefore requires more than the abstract possibility of disagreement. A criticism that cannot identify what it challenges, a counterexample that cannot enter the claim record, or a practitioner objection for which no response pathway exists has little capacity to revise the programme. Conversely, contestability does not imply that every challenge receives equal evidential weight or compels revision. Different challenges carry different standing, competence, evidence, and inferential force.

Definition 25.170 (Contestability pathway). *A contestability pathway* connects a challenge to its target, grounds, relevant correction authority, response, adjudication sta-

Table 25.9: Principal channels of collaboration and contestability in GRE

Channel	Primary object of challenge	Possible programme consequence
Criticism	Semantics, inference, evidence, formalization, norms, scope, or application	Clarification, revised warrant, dependency reanalysis, or targeted revision
Counterexample	Generality, mechanism, topology, boundary, or applicability	Scope contraction, subtype formation, mechanism revision, or claim defeat
Replication	Dependence on data, procedures, interpretation, formal derivation, or implementation	Corroboration, sensitivity discovery, non-replication, or revised validity horizon
Reinterpretation	Evidential or conceptual bridge connecting observations to claims	Alternative reading, underdetermination, changed claim status, or formulation branching
Cross-disciplinary collaboration	Domain predicates and external correction dependencies	Domain correction, translation revision, deference, or joint reconstruction
Cross-cultural collaboration	Concept portability, standing, categories, institutions, and historical assumptions	Semantic revision, regionalization, expanded standing, or new comparison classes
Public contestability	Representations, lived consequences, feasibility, harms, standing, and priorities	Corrected description, new evidence, normative reconsideration, or implementation revision
Institutional contestability	Procedures governing entry, review, preservation, funding, publication, and correction	Changed access to challenge, appeal, provenance, oversight, or programme governance

tus, dependency consequences, and resulting action, including retention, clarification, scope revision, reanalysis, branching, suspension, or retirement.

Table 25.9 summarizes the principal contestability channels developed below. The table treats collaboration as a set of correction relations rather than as co-authorship alone.

Proposition 25.171 (Challenge-to-revision traceability). *A consequential challenge strengthens GRE's revisability when the programme can reconstruct what was challenged, why the challenge had standing, how it was assessed, which dependencies were affected, and why the resulting claim or programme state was retained or changed.*

25.9.1 Criticism

Criticism is the broadest contestability channel. It can concern the meaning of a concept, the validity of an inference, the adequacy of evidence, the assumptions of a formal representation, the provenance of a normative judgment, the placement of a domain boundary, or the consequences of an applied recommendation. GRE should therefore treat criticism as typed intervention into programme architecture rather

than as an undifferentiated expression of disagreement.

Definition 25.172 (GRE criticism record). A *GRE criticism record* identifies the challenged programme component, its epistemic status and version, the critic's stated grounds, the relevant evidence or argument, the claimed scope of the problem, affected dependencies, the programme response, unresolved remainder, and any resulting revision action.

Typing matters because criticisms that appear similar can require different responses. A semantic criticism may show that two studies use *value conversion* differently. An evidential criticism may show that a proposed mechanism rests on measurements that do not identify the intended relation. A formal criticism may expose an unstated assumption required for a derivation. A normative criticism may dispute the standing rule by which affected subjects were included. A domain criticism may show that a predicate treated as economically decidable actually requires legal, ecological, historical, or technical correction authority.

A criticism can be consequential without defeating its target. It may reveal a missing scope condition, require a stronger evidential bridge, narrow an interpretation, or expose an unresolved ambiguity. The response should therefore preserve a distinction among clarification, qualification, revision, suspension, and defeat.

Definition 25.173 (Criticism-response burden). The *criticism-response burden* is the programme obligation to provide a reasoned and reconstructable response when a criticism identifies a plausible defect that would materially alter the warrant, interpretation, scope, dependency, or application of a GRE component if sustained.

The burden does not require agreement with the critic. It requires the programme to state why the criticism changes the target, leaves it unchanged, remains unresolved, or redirects the dispute to another evidential or disciplinary venue. Silence can itself become informative when a programme systematically lacks procedures for answering particular classes of criticism.

Proposition 25.174 (Typed criticism principle). *GRE should assess criticism by the kind of programme component challenged and the inferential consequence of the alleged defect, so that semantic, empirical, formal, normative, domain, and applied criticisms produce appropriately differentiated revision pathways.*

25.9.2 Counterexamples

Counterexamples are especially important for a programme whose claims vary in epistemic status and scope. A case that contradicts a universal proposition has a different force from a case that falls outside a heuristic's expected range, a historical reconstruction's evidence base, or a domain-specific mechanism's stated conditions. The analytical task is to determine whether the candidate case actually satisfies the target claim's antecedent and scope conditions and, if so, what aspect of the claim it challenges.

Definition 25.175 (GRE counterexample profile). A *GRE counterexample profile* records the target claim, its stated scope and conditions, the candidate case, evidence that the case satisfies the relevant inclusion conditions, the observed divergence, alternative explanations, possible measurement or interpretation errors, and the revision consequences that would follow if the counterexample is sustained.

A counterexample can operate at several levels. It can challenge generality by

showing that a claim fails in a case within its stated domain. It can challenge a proposed mechanism by showing that the predicted generative sequence is absent or reversed. It can challenge a typology by presenting a case that cannot be classified without distorting its properties. It can challenge a domain boundary by demonstrating that a supposedly external factor is constitutive of the phenomenon. It can also challenge an application by showing that an intervention expected to preserve options or expand relational capacity recurrently produces foreclosure under specified conditions.

Scope revision is a legitimate response when it is independently defensible. A programme can learn that a mechanism operates only under narrower institutional, historical, technological, or cultural conditions than originally proposed. Such narrowing should revise the recorded generality of the earlier claim. Redefining the scope only after each adverse case in a way that insulates the claim from possible failure would weaken contestability.

Definition 25.176 (Counterexample propagation map). *A counterexample propagation map records which downstream propositions, applications, classifications, or research questions depend materially on a claim challenged by a sustained counterexample and therefore require reassessment rather than automatic retention.*

Proposition 25.177 (Counterexample incorporation principle). *When a candidate counterexample satisfies the documented scope conditions of a GRE claim and survives reasonable evidential and interpretive scrutiny, the programme should revise the target's warrant or scope and propagate that revision through materially dependent components.*

Negative cases therefore belong to the constructive development of GRE. Their importance lies in the information they provide about boundaries, mechanisms, omitted variables, unsuitable categories, and the circumstances under which one formulation should branch or be retired.

25.9.3 Replication

Replication within GRE requires a plural conception because the programme includes empirical, historical, interpretive, formal, and applied work. Experimental repetition can be appropriate for some research designs, while historical reconstruction, qualitative inquiry, formal derivation, and institutional case analysis require different forms of independent re-examination. The common objective is to test whether a reported result depends excessively on one dataset, procedure, coding scheme, interpretation, formal implementation, or research setting.

Definition 25.178 (GRE replication attempt). *A GRE replication attempt is an independent or meaningfully separated re-examination of a prior GRE result using a procedure appropriate to that result's epistemic status, with the purpose of testing the stability, recoverability, scope, or implementation dependence of the reported finding or inference.*

For a quantitative empirical result, replication may involve re-estimation from the same or newly collected data, alternative operationalization, or application in another population. For a historical claim, it may involve independent archival reconstruction, source criticism, or reassessment using newly available records. For qualitative work, it may involve independent coding, comparison across sites, or renewed field inquiry. For a formal result, it may involve independent derivation, proof

checking, simulation reproduction, or testing alternative parameterizations. For an applied intervention, replication may concern whether the generative mechanism and consequences recur under materially comparable implementation conditions.

These procedures answer different questions. Agreement across them can increase confidence, while disagreement can locate a boundary or hidden dependence. A failed replication also has several possible interpretations: the original result may be incorrect, the later design may not instantiate the same object, the mechanism may be historically or institutionally contingent, the operationalization may differ, or the phenomenon may be unstable. The replication record should keep these possibilities distinguishable.

Definition 25.179 (Replication comparison profile). A *replication comparison profile* records the original and replication objects, data or source bases, procedures, operationalizations, historical and institutional conditions, implementation differences, result correspondence, residual discrepancies, and the revised validity horizon justified by the comparison.

Proposition 25.180 (Status-sensitive replication principle). *GRE should evaluate replication through procedures appropriate to the epistemic status and evidence relation of the original result; stability across relevant replications can strengthen warrant, while non-replication should trigger diagnosis of error; scope, interpretation, or contextual dependence before broader conclusions are drawn.*

Replication thus functions as a generator of scope knowledge as well as a check on correctness. A result that reproduces only under a narrow institutional configuration may remain useful if that configuration is made explicit.

25.9.4 Reinterpretation

Reinterpretation concerns the bridge between available material and the claim inferred from it. The same archive, interview corpus, institutional record, statistical pattern, or formal representation can sometimes support more than one serious interpretation. GRE's inverse-problem epistemology makes such underdetermination expected in many domains. Programme contestability therefore requires alternative interpretations to remain visible when the evidence does not uniquely select among them.

Definition 25.181 (GRE reinterpretation dossier). A *GRE reinterpretation dossier* records the shared evidential material, the prior interpretation, the alternative interpretation, the concepts and inferential bridges on which they diverge, evidence capable of discriminating between them, consequences for downstream claims, and any remainder that remains underdetermined.

Reinterpretation can expose hidden assumptions. A pattern previously interpreted as voluntary coordination may be redescribed as dependence once exit conditions are examined. A historical episode described as value generation may look different when unrecorded costs or excluded subjects enter the evidential field. A network representation interpreted as influence may support only association if the causal bridge is weaker than originally assumed. These revisions concern the relation between representation and inference rather than merely vocabulary.

Alternative interpretation should also remain constrained. A reinterpretation gains programme relevance when it has explicit semantics, preserves the eviden-

tial record, identifies the inferential change, and exposes consequences that can in principle be compared. An interpretation that shifts meaning whenever adverse evidence appears creates semantic immunity rather than contestability.

Definition 25.182 (Reinterpretation discrimination burden). The *reinterpretation discrimination burden* is the requirement that materially competing interpretations identify the observations, arguments, source relations, or future evidence that could alter their relative warrant, or explicitly state when current evidence leaves them undetermined.

Proposition 25.183 (Interpretive plurality principle). *GRE should preserve materially serious alternative interpretations when available evidence does not warrant unique selection, while restricting downstream conclusions to those supported by the interpretation actually adopted or robust across the surviving alternatives.*

Reinterpretation thereby connects contestability with the plural-formulation architecture of Section 25.8. A sufficiently consequential interpretive divergence may become a formulation branch point rather than an ambiguity to be removed editorially.

25.9.5 Cross-Disciplinary Collaboration

Cross-disciplinary collaboration becomes necessary when an economic question contains predicates whose warrant depends partly on neighboring domains. GRE may investigate the economic consequences of legal validity, ecological thresholds, historical sequence, educational quality, technological capability, or political authority, while the programme does not thereby acquire principal correction authority over those predicates. Collaboration should therefore be organized around distributed competence and reciprocal correction.

Definition 25.184 (Cross-disciplinary contestability interface). A *cross-disciplinary contestability interface* specifies a shared research object, the claims contributed by each participating domain, predicate-specific correction authority, translation rules, evidential responsibilities, unresolved jurisdictional overlap, and the GRE components that should change when an external-domain correction is sustained.

The interface differs from disciplinary borrowing. Borrowing can import a concept as a fixed input. Collaboration creates a pathway through which historians, legal scholars, ecologists, engineers, educators, political theorists, or other specialists can challenge how GRE has represented the object and can require revision when the challenge falls within their relevant competence. GRE can likewise return economic findings that alter neighboring-domain interpretations without presuming that economic relevance establishes disciplinary priority.

This relation is especially important where concepts share vocabulary across disciplines while carrying different meanings. *Institution*, *capacity*, *value*, *power*, *right*, *risk*, or *sustainability* can enter several literatures with distinct inferential roles. A collaborative interface should preserve those differences before seeking common structure.

Definition 25.185 (Distributed correction authority). *Distributed correction authority* is the allocation of primary and contributory correction roles according to the predicate, evidence, method, and institutional competence relevant to a disputed claim, rather than according to ownership of the larger research project.

Proposition 25.186 (Cross-disciplinary correction principle). *When a GRE conclusion*

materially depends on a claim whose principal warrant lies in another domain, sustained correction from that domain should propagate into the GRE conclusion through an explicit interface even when the economic analysis itself remains internally coherent.

Cross-disciplinary collaboration therefore increases programme answerability by creating external correction routes. Its success is measured partly by whether participants can revise one another's relevant claims, not merely by whether several disciplinary vocabularies appear in the same study.

25.9.6 Cross-Cultural Collaboration

Cross-cultural collaboration tests whether GRE categories, comparisons, value concepts, subject assumptions, institutional classifications, and evidential practices travel across historically and culturally differentiated settings. The relevant analytical units should remain specific. Broad civilizational or national labels can conceal internal plurality, migration, class, language, region, generation, institutional variation, and contested traditions. GRE therefore treats cross-cultural inquiry as comparison among situated interpretive and institutional configurations rather than as comparison among internally homogeneous cultures.

Definition 25.187 (Cross-cultural contestability profile). *A cross-cultural contestability profile records the GRE concept or claim under examination, the historically situated settings compared, relevant language and translation issues, institutional differences, subject positions, local categories, normative standing assumptions, observed mismatches, and the programme revisions proposed in response.*

Several forms of correction can result. A concept may prove semantically narrower than assumed because another setting lacks an equivalent category. A typology may require additional cases. A value account may reveal standing rules that were treated as universal despite being historically local. A measurement may fail because its indicators encode one institutional practice. A proposed causal mechanism may depend on background relations absent elsewhere. In each case, cross-cultural collaboration can alter the framework itself rather than merely append another regional example.

Translation is central to this process. Lexical equivalence is insufficient where concepts occupy different relational positions, carry different histories, or presuppose different institutional distinctions. Participants with situated linguistic, historical, and practical competence should therefore be able to contest the translation architecture through which a GRE claim is transported.

Definition 25.188 (Cultural portability assessment). *A cultural portability assessment evaluates which semantics, mechanisms, categories, standing rules, indicators, and inferential relations of a GRE component remain warranted across specified settings, which require translation or regionalization, and which fail to travel without material reconstruction.*

Proposition 25.189 (Cross-cultural revision principle). *When cross-cultural inquiry reveals that a GRE concept or claim depends materially on historically local semantics, institutions, standing rules, or evidence practices, the programme should regionalize, translate, or revise the affected component rather than preserve broader scope by terminological equivalence alone.*

Cross-cultural contestability therefore contributes directly to theory construction. It can identify candidate invariants, but it can equally reveal non-transferable struc-

tures whose preservation is necessary for domain accuracy and intellectual humility.

25.9.7 Public Contestability

GRE frequently studies relations in which people, communities, organizations, workers, consumers, recipients of public services, and other affected parties possess knowledge unavailable from formal datasets alone. They can contest descriptions of their practices, classifications imposed upon them, assumptions about feasible action, accounts of harm, distributions of standing, or institutional representations of consent and participation. Public contestability provides a pathway by which such challenges can enter research and application without assuming that experiential standing settles every empirical or normative question.

Definition 25.190 (Public contestability interface). A *public contestability interface* is a documented procedure through which persons or collectivities materially represented, affected, or governed by a GRE analysis can challenge relevant descriptions, categories, evidence, assumptions, value premises, or applications and receive a traceable response connected to possible revision.

Different forms of public contribution carry different epistemic roles. Participants may possess first-person knowledge of constraints, tacit knowledge of institutional practice, records unavailable to researchers, collective memory, knowledge of implementation failure, or normative claims about standing and acceptable risk. These contributions can correct research even when they do not confer principal authority over statistical validity, legal interpretation, ecological thresholds, or other predicates requiring additional expertise.

Meaningful contestability also depends on accessibility. A technically public model can remain practically insulated if its objects, assumptions, data transformations, uncertainty, or avenues of challenge are unintelligible to the people expected to contest it. Accessibility requirements should be proportional to the consequences of the analysis and the roles expected of affected participants.

Definition 25.191 (Representational challenge). A *representational challenge* is a contestation by an affected or knowledgeable party claiming that a GRE description, category, proxy, subject model, or inferred relation materially misrepresents the object or consequences relevant to the analysis.

A representational challenge should be evaluated rather than treated as automatically dispositive. Researchers may retain a contested category if they can justify its analytical purpose and evidential basis. The challenge nevertheless creates a response burden where the representation materially affects conclusions, standing, or intervention.

Proposition 25.192 (Affected-party answerability). *When GRE represents or informs consequential action toward identifiable affected parties, the programme should provide proportionate avenues through which materially relevant representational, experiential, and normative challenges can enter the analysis and receive documented responses.*

Public contestability also has a power dimension. The practical ability to challenge research depends on language, time, resources, institutional recognition, access to records, and protection from retaliation. A nominal invitation to comment therefore does not by itself establish meaningful contestability.

25.9.8 Institutional Contestability

Contestability ultimately depends on institutions that determine who can raise a challenge, where it is recorded, who is expected to answer, what evidence can be accessed, whether negative findings are publishable, and how revisions persist over time. Journals, repositories, universities, research groups, public agencies, funding arrangements, ethics procedures, data infrastructures, professional associations, and community organizations can support these functions. They can also create gatekeeping, path dependence, conflicts of interest, or asymmetric costs that suppress correction.

Definition 25.193 (Institutional contestability condition). An *institutional contestability condition* is a configuration in which relevant challenges have accessible entry points, identifiable response responsibility, sufficient evidential access, proportionate independence from the challenged interest, traceable adjudication or unresolved status, and durable preservation of the resulting record.

No single institutional form is sufficient across the programme. Formal peer review may detect some errors while missing practitioner knowledge. Public consultation may surface implementation harms while lacking access to confidential data or technical derivations. Replication repositories can preserve computational materials while leaving interpretive disputes unresolved. Cross-disciplinary panels can broaden correction authority while reproducing their own exclusions. GRE therefore benefits from multiple, partially independent contestability routes.

Definition 25.194 (Contestability failure). A *contestability failure* occurs when a materially relevant challenge is systematically prevented from reaching, testing, or revising its programme target because entry, evidence, response, independence, escalation, or preservation mechanisms are inadequate.

Contestability failure can occur even where criticism is formally permitted. A challenge may be too costly to submit, inaccessible in the required language or format, dependent on data controlled by the challenged institution, or incapable of producing a durable correction. Institutional analysis should therefore examine the generative conditions of criticism itself: which relations make correction possible, which positions can impose a response burden, and which challenges disappear without leaving a research trace.

Definition 25.195 (GRE contestability portfolio). A *GRE contestability portfolio* is the programme-level record of available criticism, counterexample, replication, reinterpretation, cross-disciplinary, cross-cultural, public, and institutional challenge pathways, including their entry conditions, correction authorities, unresolved cases, and known access asymmetries.

Proposition 25.196 (Plural contestability principle). *GRE's openness is more credible when consequential claims can be challenged through several appropriately differentiated pathways and when the programme records both successful corrections and known barriers to correction.*

Collaboration and contestability therefore give operational content to GRE's commitment to revisability. Criticism becomes useful when it can reach specified targets; counterexamples when they can revise scope or mechanism; replication when it can expose stability and dependence; reinterpretation when alternative inferential bridges remain comparable; and collaboration when correction authority can cross disciplinary, cultural, public, and institutional boundaries. These mechanisms also create a further requirement. A programme cannot learn from contestation if the

challenged claims, evidence, alternative interpretations, negative results, and revision decisions disappear as soon as a new version is produced. Section 578 therefore turns to preservation and provenance as the research memory required for contestability to accumulate rather than repeatedly restart.

25.10 Preservation and Provenance

Section 25.9 established contestability as a programme mechanism through which criticism, counterexamples, replication, reinterpretation, and external correction can reach identifiable GRE components and produce traceable consequences. Such contestability accumulates only when the objects of challenge and the reasons for their retention, revision, branching, or retirement remain reconstructable over time. The present section therefore specifies the preservation and provenance architecture required by an open research programme. Its objective is to identify what should be retained, which relations among records matter, how provenance differs across concepts, claims, data, and models, and why negative results and alternative interpretations belong within programme memory. The discussion proceeds through concept lineage, claim warrant, data transformations, model assumptions, negative results, interpretive alternatives, revision histories, and research memory. Its method is dependency-sensitive and historically reconstructive: preservation is evaluated by the future analytical work a record can support, while provenance records the relations through which a present programme state became warranted, contested, transformed, or superseded.

Definition 25.197 (GRE preservation-provenance architecture). A *GRE preservation-provenance architecture* is a programme-level arrangement that retains materially consequential research objects together with the semantic, evidential, methodological, formal, normative, historical, and revision relations required to reconstruct how those objects entered, changed within, or left the programme.

Preservation and provenance perform different functions. Preservation maintains access to an object or record. Provenance makes its lineage intelligible. A stored dataset without collection and transformation history may remain available while losing much of its evidential meaning. A superseded concept definition can remain textually preserved while becoming difficult to compare if the reason for revision is absent. A model file can survive while the assumptions, parameter choices, training conditions, or intended interpretation that gave it analytical meaning disappear. GRE therefore treats durable storage as one component of research memory rather than as its complete form.

Definition 25.198 (Programme provenance relation). A *programme provenance relation* is a documented relation connecting a preserved object to a materially relevant source, predecessor, transformation, assumption, evidential basis, interpretive decision, criticism, revision event, branch, or successor.

The relevant unit of preservation is consequently relational. Later researchers should be able to recover both an object and enough of its dependency structure to understand what it meant and what supported it at a specified programme state. The required depth varies with consequence, uncertainty, dependency, and practical feasibility. Minor editorial changes ordinarily require less provenance than a revised definition that alters several downstream propositions or an applied model that af-

Table 25.10: Principal preservation objects and provenance requirements in GRE

Preserved object	Material provenance	Future analytical function
Concept	Definition, semantic lineage, domain, translations, disputes, predecessor and successor meanings	Recover semantic change and prevent accidental equivalence across versions
Claim	Exact formulation, status, scope, assumptions, warrant, dependencies, criticism, outcome	Reconstruct why a claim was accepted, qualified, suspended, defeated, or retained
Data	Source, collection context, measurement, inclusion rules, transformations, access conditions	Reassess evidential fit and reproduce or reinterpret analytical transformations
Model	Purpose, assumptions, inputs, implementation, parameterization, diagnostics, version, interpretation	Compare model branches and identify dependence on formal or computational choices
Negative result	Target, conditions, procedure, failure mode, uncertainty, interpretation	Prevent selective programme memory and reopen previously unsuccessful paths under changed conditions
Alternative interpretation	Shared evidence, divergent inferential bridge, assumptions, discriminating evidence, status	Preserve underdetermination and enable later reinterpretation without reconstructing lost alternatives
Revision history	Previous state, trigger, rationale, dependency effects, successor state, unresolved remainder	Explain programme change and distinguish correction, branching, retirement, and succession
Research memory	Preserved objects, provenance relations, access conditions, unresolved records, retention priorities	Support cumulative contestability, re-analysis, comparison, and future re-epistemization

fects consequential institutional decisions.

Table 25.10 summarizes the principal preservation objects developed in this section and the provenance relations that make them analytically reusable.

Proposition 25.199 (Reconstructable preservation principle). *Preservation strengthens an open GRE programme when later inquiry can reconstruct the material relations through which a preserved object acquired its meaning, warrant, limitations, and programme consequences, rather than merely recover the object’s latest textual or computational form.*

25.10.1 Concept Provenance and Semantic Lineage

Concepts are among the most frequently reused programme objects and among the easiest to preserve incompletely. The same label can acquire a revised definition, narrower domain, additional distinction, new measurement bridge, altered normative implication, or different relation to neighboring theories. A later reader who encoun-

ters only the current definition may be unable to determine whether an earlier claim used the same concept in the same sense. Concept provenance therefore records semantic lineage rather than treating vocabulary as historically stable by default.

Definition 25.200 (GRE concept lineage record). A *GRE concept lineage record* identifies a concept's versioned definition, analytical role, domain and scale, predecessor formulations, successor formulations, materially relevant distinctions, translation relations, documented disputes, and the reasons for consequential semantic revision.

A lineage record is especially important for concepts that recur across chapters or domains. Terms such as *generativity*, *value*, *power*, *relational capacity*, *participation*, and *economic order* can carry family resemblance across contexts while requiring different predicates, evidence, or operationalization in specific inquiries. Preservation should make these relations explicit enough that recurrence does not create an unsupported presumption of identity.

Definition 25.201 (Semantic continuity assessment). A *semantic continuity assessment* compares two versions or uses of a concept by recording which defining properties, inferential roles, domain conditions, measurement bridges, and normative implications remain stable and which have changed.

Semantic continuity can be partial. A later formulation may preserve the relational core of a concept while changing its formal representation. A cross-domain translation may preserve a structural question while changing the domain predicate that determines whether an instance qualifies. A historical reinterpretation may show that a category previously treated as stable depended on an institution or vocabulary that did not exist in the earlier period. These cases require a lineage that records continuity and discontinuity separately.

Concept preservation should also retain abandoned distinctions when their removal affected later reasoning. Deleting an unsuccessful conceptual branch can make subsequent theory appear more linear and inevitable than the research process actually was. Retaining the branch, its motivation, and its reason for abandonment can reveal which ambiguities have already been examined and which assumptions were required to resolve them.

Definition 25.202 (Semantic provenance loss). *Semantic provenance loss* occurs when a concept remains in use while the record no longer supports reconstruction of materially relevant changes in its definition, inferential role, domain, or relation to earlier formulations.

Semantic provenance loss can generate false agreement. Two authors may appear to endorse the same GRE proposition while using different versions of a central term. It can also generate false disagreement when labels differ despite substantially shared analytical content. A preserved semantic lineage gives later comparison a more reliable object than terminology alone.

Proposition 25.203 (Concept-lineage principle). *Consequential GRE concepts should be preserved as versioned semantic lineages when changes in their meaning, domain, or inferential role would alter the interpretation of earlier or later programme claims.*

25.10.2 Claim Provenance and Warrant Lineage

Claims require a different provenance architecture because their central problem is warrant. Section 25.2 distinguished claims from proposals, hypotheses, heuristics,

formal representations, domain-specific results, open problems, and unresolved disagreements. Preservation should maintain that status discipline over time. A sentence that was originally proposed as a heuristic should not later appear as a settled result merely because its qualification disappeared during repeated summarization.

Definition 25.204 (GRE claim provenance record). A *GRE claim provenance record* preserves the claim's exact versioned formulation, epistemic status, stated scope, assumptions, supporting evidence or argument, dependency relations, known counterevidence, material criticisms, revision conditions, and current programme disposition.

The exact formulation matters because small changes can alter evidential burden. A claim that a mechanism *can* occur under specified conditions differs from a claim that it *typically* occurs, and both differ from a claim of general necessity. Preservation should therefore keep the formulation against which evidence and criticism were originally evaluated.

Definition 25.205 (Warrant lineage). A *warrant lineage* is the reconstructable sequence through which the support for a claim is introduced, supplemented, challenged, reinterpreted, narrowed, replaced, or withdrawn across programme versions.

Warrant lineage differs from citation history. Citations can identify intellectual or evidential sources while leaving the inferential role of each source unspecified. A warrant lineage records which evidence supports which component of a claim, which assumptions connect evidence to conclusion, which criticisms reach those connections, and how the programme responds. It can therefore show that a claim survived because new evidence corroborated it, because its scope was narrowed, because an alternative explanation was rejected, or because the issue remains unresolved.

Definition 25.206 (Claim-state transition). A *claim-state transition* is a documented change in a claim's epistemic status, scope, warrant, dependency position, or programme disposition produced by new evidence, argument, criticism, reinterpretation, or revision.

Claim-state transitions should preserve defeated and superseded states when they remain relevant to understanding later theory. A claim can be retired while its failure contributes to a new distinction or research question. A hypothesis can lose empirical support while a formal representation derived from it remains useful under a different interpretation. Provenance should permit these differentiated outcomes to remain visible.

The level of record should be proportional to programme consequence. A local wording change can be documented lightly. A claim that anchors several downstream sections, guides data collection, or enters policy application warrants deeper preservation because later revision may require tracing its effects across a larger dependency structure.

Proposition 25.207 (Warrant-reconstruction principle). *For claims with material downstream dependencies, GRE should preserve enough warrant lineage to reconstruct why each consequential claim state was accepted, qualified, contested, suspended, defeated, or retained at the time it was used.*

25.10.3 Data Provenance and Evidential Lineage

Data preservation concerns more than retaining files. GRE frequently works with historically generated classifications, institutional records, surveys, measurements, administrative data, archives, computational traces, interviews, and mixed evidential forms. Their evidential meaning depends on how observations were produced, selected, transformed, and linked to the relational objects or processes under study. Data provenance therefore belongs to epistemic interpretation as well as reproducibility.

Definition 25.208 (GRE data provenance record). A *GRE data provenance record* identifies the source and collection context of data, relevant measurement or classification procedures, sampling and inclusion rules, exclusions and missingness, transformations, linkage operations, derived variables, access conditions, version changes, and known limitations that bear on evidential interpretation.

The record should distinguish source data from derived data. A derived variable may depend on recoding, aggregation, imputation, normalization, textual interpretation, model-based inference, or linkage across sources. Each transformation can alter what later analysis can reasonably infer. Preserving only the final analytic table obscures these steps and can make a relational interpretation appear to arise directly from observations that were themselves heavily processed.

Definition 25.209 (Evidential transformation chain). An *evidential transformation chain* is the documented sequence connecting source observations to the derived representations used in an analysis, including the transformations, assumptions, classification decisions, and uncertainty introduced at each materially consequential step.

GRE's historical orientation adds another requirement. Categories embedded in records may reflect institutions, legal classifications, administrative purposes, technological capacities, or social conventions specific to their time and place. Provenance should preserve enough contextual information to prevent later researchers from treating a historically generated category as a transparent measure of a timeless object. This concern applies equally to contemporary digital traces whose availability is shaped by platform architecture, access rules, and recording practices.

Preservation can conflict with privacy, confidentiality, legal obligations, community governance, security, or contractual restrictions. Research memory therefore does not imply unrestricted retention or public disclosure. Where direct preservation of sensitive data is inappropriate, the programme can preserve metadata, transformation logic, access conditions, synthetic or redacted derivatives, secure references, and explicit statements of what later researchers cannot independently inspect.

Definition 25.210 (Provenance sufficiency under access constraint). *Provenance sufficiency under access constraint* is the condition in which a research record preserves the maximum ethically, legally, and practically appropriate information needed to assess evidential origin and transformation while explicitly documenting residual limits on independent inspection or replication.

A provenance record should also preserve data corrections. Silent replacement of an erroneous file can improve the current analysis while erasing the reason earlier results differed. Versioned corrections permit later researchers to distinguish changes caused by theory from changes caused by data repair.

Proposition 25.211 (Evidential-lineage principle). *GRE analyses should preserve the materially consequential lineage connecting observations to analytical representations,*

including transformation and access constraints, whenever those relations affect interpretation, replication, or the scope of warranted inference.

25.10.4 Model Provenance and Assumption Lineage

Models concentrate many layers of choice. A conceptual model can encode a particular boundary around the object of inquiry. A formal model can depend on definitions, structural assumptions, mathematical simplifications, and parameter restrictions. A computational model adds implementation, software, initialization, numerical procedure, and hardware or environment dependencies. A statistical or machine-learning model can further depend on training data, feature construction, optimization choices, evaluation metrics, and decision thresholds. Model preservation should therefore retain the assumptions and implementation conditions that make an output interpretable.

Definition 25.212 (GRE model provenance record). A *GRE model provenance record* identifies a model's analytical purpose, version, represented objects, assumptions, inputs, parameterization, implementation or derivation, evaluation procedures, diagnostics, known failure conditions, intended interpretation, dependencies, and relation to predecessor, competing, or successor models.

The record should keep analytical purpose explicit. The same mathematical or computational structure can serve descriptive, explanatory, exploratory, predictive, counterfactual, or heuristic roles. Reusing a model in a new role without preserving that change can create an unsupported expansion of claim strength.

Definition 25.213 (Assumption lineage). An *assumption lineage* records the introduction, justification, relaxation, replacement, and downstream consequences of assumptions that materially shape a model's behavior or interpretation.

Assumption lineage is especially important when later formulations appear to improve a model by adding complexity. A new version may fit observations better while changing the object represented, the parameter interpretation, or the conditions under which earlier propositions held. Provenance allows comparison of models as structured alternatives rather than as a simple sequence from inferior to superior.

Definition 25.214 (Model branch record). A *model branch record* documents a point at which materially different model variants continue in parallel because they encode different assumptions, purposes, evidence relations, or interpretive commitments whose relative adequacy remains unresolved or context-dependent.

Model branches can preserve productive disagreement identified in Section 25.8. They also prevent later computational convenience from silently selecting one theoretical interpretation. A model that becomes easier to estimate or implement does not thereby acquire stronger ontological standing. The ontological restraint developed earlier in the book continues to apply to preserved formal and computational artifacts.

Executable preservation, where feasible, strengthens provenance by retaining code, environment specifications, parameter files, and tests. Executability remains only one component. A perfectly reproducible computation can still rest on a poor conceptual translation or an inappropriate evidential bridge. Model memory should therefore connect implementation reproducibility to semantic and epistemic provenance rather than substitute one for the other.

Proposition 25.215 (Model-lineage principle). *GRE should preserve consequential models together with the assumptions, purposes, evidence relations, and implementation conditions needed to distinguish computational reproducibility from substantive validity and to compare model branches across programme versions.*

25.10.5 Negative Results as Programme Evidence

An open research programme requires memory of paths that did not produce the expected result. Negative findings can reveal scope boundaries, failed mechanisms, unstable measurements, non-identification, unsuccessful translations, model sensitivity, implementation barriers, or unresolved contradictions. Their preservation reduces the risk that programme history becomes a retrospective sequence of successful formulations while repeated failures disappear from view.

Definition 25.216 (GRE negative-result record). *A GRE negative-result record preserves a research question or target, the relevant hypothesis or expectation, methods and conditions, evidence obtained, the sense in which the expected result was absent or failed, plausible alternative explanations, uncertainty, and the programme implications supported by the result.*

The category should remain typed. A statistically imprecise estimate is different from evidence favoring a null relation. A failed replication differs from a study whose design cannot identify the target mechanism. A formal derivation that cannot be completed under given assumptions differs from a proof that a proposed structure is inconsistent. A translation failure between disciplines can be theoretically important without implying that either source theory is wrong. Preservation should record the kind of negative result so later researchers do not strengthen its meaning retrospectively.

Definition 25.217 (Failure-context profile). *A failure-context profile records the domain, scale, data conditions, method, assumptions, implementation conditions, and interpretive criteria under which a negative result occurred, together with changes that might make later reconsideration informative.*

Failure context matters because later evidence, methods, or technologies can alter the significance of an earlier negative result. A computationally infeasible analysis may become tractable. A measurement problem may receive a new instrument. A historical archive may become available. A category once treated as homogeneous may later be disaggregated. Preserving failure conditions therefore creates resources for the future re-epistemization developed in the next section.

Negative-result preservation also provides a check against internal selection pressures. Researchers may preferentially circulate successful models, striking mechanisms, or theoretically congenial findings. Programme memory should preserve serious unsuccessful attempts when their absence would distort assessment of robustness, novelty, or evidential balance.

Definition 25.218 (Negative-result reuse condition). *A negative-result reuse condition identifies the material changes in evidence, method, theory, domain, technology, or interpretation that could justify reopening an earlier negative result rather than merely repeating the same unsuccessful inquiry.*

Preservation does not require equal attention to every failed attempt. Trivial errors, exploratory dead ends without downstream significance, and redundant fail-

ures can be summarized or discarded according to proportionate retention rules. The relevant question is whether loss of the record would remove information needed to assess programme robustness, avoid uninformative repetition, reconstruct revision, or recognize changed conditions.

Proposition 25.219 (Negative-result preservation principle). *GRE should preserve consequential negative results with their failure contexts when those records can constrain later claims, reveal programme boundaries, prevent selective memory, or provide a basis for informative reanalysis under changed conditions.*

25.10.6 Alternative Interpretations and Evidential Underdetermination

Evidence often supports more than one serious interpretation. Section 25.8 treated competing historical, ontological, value, power, justice, and formal formulations as potentially productive programme plurality. Preservation should retain the interpretive alternatives that made such plurality analytically meaningful, including alternatives that were temporarily disfavored but not decisively defeated.

Definition 25.220 (Interpretive branch record). An *interpretive branch record* preserves a set of serious alternative interpretations of shared or overlapping evidence together with their conceptual assumptions, inferential bridges, supporting and conflicting evidence, discriminating observations, programme consequences, and current comparative status.

The purpose is not to archive every conceivable reading. An alternative belongs in the record when it has sufficient argumentative or evidential standing that choosing among interpretations materially affects conclusions. This threshold preserves contestability while avoiding an unbounded catalogue of possibilities.

Definition 25.221 (Interpretive closure event). An *interpretive closure event* is a documented programme decision to privilege, merge, regionalize, suspend, or retire interpretive alternatives on the basis of stated evidence, argument, scope, or practical decision requirements.

Closure can remain provisional. A programme may adopt one interpretation for current analysis because it has stronger warrant while retaining the alternatives and the evidence that could reopen them. Application may also require a working interpretation before theoretical underdetermination is fully resolved. In that case the record should distinguish decision necessity from epistemic settlement.

Alternative interpretations are especially important for historical and cross-cultural inquiry, where later archival access, language competence, conceptual reconstruction, or changed historical position can alter what counts as a plausible reading. They also matter for contested contemporary institutions, where different participants may possess evidence or semantic knowledge unavailable from one analytical position.

Definition 25.222 (Dormant interpretation). A *dormant interpretation* is a preserved interpretation that lacks sufficient current warrant for active use but remains neither defeated nor analytically irrelevant because identifiable future evidence or argument could restore its comparative standing.

The category permits GRE to preserve underdetermination without forcing equal present weight. It also reduces hindsight bias: a later dominant account need not

erase the fact that earlier evidence left several serious possibilities open.

Proposition 25.223 (Interpretive-preservation principle). *When materially different interpretations remain serious under the available evidence, GRE should preserve their inferential structures and comparative status so later reanalysis can revisit the disagreement without reconstructing lost alternatives from fragments.*

25.10.7 Revision Histories and Decision Provenance

Section 25.7 developed historically revisable and versioned theory. Preservation gives that architecture operational memory. A revision history should record more than successive files. It should make visible which programme object changed, what triggered the change, why a particular response was chosen, which dependencies were affected, and what unresolved remainder continued into the successor version.

Definition 25.224 (GRE revision event). *A GRE revision event is a documented transition in which a programme component changes materially in semantics, epistemic status, scope, evidence, method, formal representation, normative warrant, domain placement, dependency structure, or programme disposition.*

This definition distinguishes substantive revision from ordinary textual editing. Copyediting can alter expression without changing programme content. A semantic revision may change the meaning of a term while leaving the surrounding prose similar. A scope revision can preserve a sentence while narrowing the population or historical range to which it applies. Decision provenance therefore requires comparison at the level of analytical function rather than file difference alone.

Definition 25.225 (Revision decision record). *A revision decision record identifies the pre-revision state, trigger, relevant criticism or evidence, considered alternatives, selected action, rationale, dependency consequences, unresolved remainder, responsible decision context, and successor state.*

The record of considered alternatives is important when several responses were reasonable. A programme may answer a counterexample by narrowing scope, introducing a subtype, revising a mechanism, or abandoning a claim. Preserving the rejected options helps later researchers understand why the chosen revision appeared preferable under the evidence and assumptions then available.

Definition 25.226 (Dependency-aware revision history). *A dependency-aware revision history connects revision events to the downstream and upstream programme components whose interpretation, warrant, or applicability may change as a consequence.*

Such histories reduce local correction that leaves incompatible downstream claims untouched. They also make it possible to revisit earlier decisions when a foundational assumption changes. A revised value concept, for example, may affect measurement choices, justice arguments, and application criteria developed in different chapters. Provenance should expose these relations sufficiently for later integration work.

Revision histories should preserve superseded states without treating them as equally current. Clear status marking can separate active, legacy, archived, defeated, and successor components. This combination of preservation and disposition enables historical reconstruction without creating ambiguity about the programme's present state.

Definition 25.227 (Revision provenance gap). *A revision provenance gap occurs*

when a programme state changes materially but the surviving record does not adequately identify the trigger, rationale, dependency consequences, or relation between predecessor and successor states.

Revision provenance gaps weaken later contestability because critics may be unable to determine whether an objection has already been considered, why an assumption disappeared, or which evidence produced a conceptual change. They also make programme succession appear smoother than it was.

Proposition 25.228 (Revision-legibility principle). *Consequential GRE revisions should remain legible as decisions in a dependency-bearing theoretical history, with enough provenance to distinguish semantic change, evidential correction, scope revision, branching, retirement, and programme succession.*

25.10.8 Research Memory and Re-Epistemization Capacity

The preceding preservation objects form a research memory when their relations can support later inquiry. Research memory is therefore neither a complete archive of everything produced nor a repository containing only final outputs. It is a structured capacity to recover consequential intellectual states, evidential pathways, disagreements, failures, and revisions with enough context for new researchers, methods, and historical positions to evaluate them again.

Definition 25.229 (GRE research memory). *GRE research memory* is the distributed and versioned preservation of programme objects and provenance relations required to reconstruct consequential meanings, warrants, alternatives, failures, and revisions for later comparison, contestation, replication, reinterpretation, and reanalysis.

The memory is distributed because no single repository or format can adequately preserve every object. Text, data, code, model specifications, diagrams, decision records, criticism, correspondence where ethically appropriate, version metadata, and access-controlled materials may require different infrastructures and governance. The programme-level requirement is relational interoperability: records should contain enough stable identifiers and provenance information that materially linked objects can be found and interpreted together.

Definition 25.230 (Research-memory continuity). *Research-memory continuity* is the condition in which changes of personnel, institution, technology, repository, format, or programme version do not sever the material provenance relations needed to reconstruct consequential research states.

Continuity is vulnerable to mundane failures. File formats become obsolete, links decay, repositories close, access permissions change, undocumented code stops running, tacit knowledge leaves with researchers, and terminology shifts. Institutional contestability from Section 25.9 therefore extends into preservation governance: the programme should know which memory functions depend on particular institutions and which records would become inaccessible if those arrangements fail.

Preservation also has costs. Unlimited retention can impose storage, curation, privacy, security, and interpretive burdens while making consequential records harder to locate. GRE therefore requires selection criteria rather than total accumulation.

Definition 25.231 (Proportionate preservation priority). A *proportionate preservation priority* assigns greater retention and provenance depth to programme objects with higher downstream dependence, uncertainty, contestation, practical

consequence, irreversibility, uniqueness, or value for future discrimination, while allowing lighter treatment of redundant or low-consequence materials.

The criterion is revisable and context-sensitive. A seemingly minor record can later become important if new evidence reveals that it contains a unique observation or preserves an abandoned conceptual path. Selection decisions should therefore preserve their own rationale when exclusion could materially shape future research memory.

Definition 25.232 (Re-epistemization readiness). *Re-epistemization readiness* is the degree to which preserved programme materials retain sufficient provenance, accessibility, status information, and dependency structure to be re-evaluated when new evidence, methods, technologies, historical positions, domains, or normative frameworks become available.

Re-epistemization readiness converts preservation from retrospective record keeping into prospective epistemic capacity. A dataset whose classifications are documented can be reanalyzed with new models. A negative result whose conditions are preserved can be reconsidered after a methodological advance. A dormant interpretation can regain relevance when new archives appear. A superseded concept can be compared with a later domain translation. A revision record can reveal that an apparently settled conclusion depended on a constraint that no longer holds.

Research memory also supports programme accountability. Later researchers can examine whether criticism was answered, whether counterevidence was incorporated, whether negative findings were selectively forgotten, whether external correction changed the programme, and whether a claimed innovation had already appeared in an earlier branch. Provenance therefore contributes to both knowledge accumulation and fair attribution of intellectual development.

Definition 25.233 (Research-memory loss). *Research-memory loss* occurs when disappearance, inaccessibility, undocumented transformation, semantic drift, or provenance failure removes information needed to reconstruct a consequential programme state or to evaluate its relation to later work.

Proposition 25.234 (Memory-to-re-epistemization principle). *GRE's capacity for future correction increases when preservation maintains not only research outputs but also the provenance relations, unresolved alternatives, negative results, and revision histories required for later investigators to ask materially new questions of earlier programme states.*

Preservation and provenance therefore supply the temporal infrastructure of an open GRE programme. Concepts remain interpretable through semantic lineage; claims remain answerable through warrant lineage; data remain assessable through evidential transformation records; models remain comparable through assumption and implementation provenance; negative results and alternative interpretations remain available for renewed discrimination; and revision histories preserve the reasons through which programme states changed. Research memory emerges from these connected records and gives contestability a cumulative rather than episodic form. The next section develops the corresponding future-facing process: re-epistemization under new evidence, methods, technologies, historical positions, domains, and normative frameworks.

25.11 Future Re-Epistemization

Section 25.10 established the preservation and provenance conditions under which a later research community can reconstruct the meanings, warrants, evidential transformations, assumptions, alternatives, negative results, and revision decisions of an earlier GRE programme state. Preservation creates an epistemic option; the present section examines how that option can be exercised. Its role is to specify future re-epistemization as a programme-level process through which inherited GRE objects are reopened under materially changed conditions of inquiry. Its objective is to distinguish the principal triggers of reopening, identify what can legitimately change in an inherited claim or interpretation, and preserve the difference between later knowledge and the historical epistemic position from which the earlier object was produced. The discussion proceeds through new evidence, methods, technologies, historical positions, domains, and normative frameworks before distinguishing reanalysis from reinterpretation. The method is comparative and provenance-sensitive: a later epistemic state is compared with a reconstructable earlier state, and revision is attributed to identifiable changes rather than to an undifferentiated assumption of intellectual progress.

The book has used re-epistemization in several contexts. Chapter 17 developed it as a capacity of an epistemic economy to reopen inherited knowledge under changed evidential, methodological, conceptual, technological, institutional, or normative conditions. Chapter 20 treated future re-epistemization as a requirement of provisional programme closure. The present section gives the concept a narrower closing function. It asks how GRE itself should be reopened after preservation has made comparison possible.

Definition 25.235 (GRE re-epistemization). A *GRE future re-epistemization process* is a provenance-preserving comparison between an earlier GRE research object and a later epistemic configuration in which materially changed evidence, methods, technologies, historical position, domain knowledge, normative frameworks, analytical operations, or interpretations can alter the object's warranted meaning, scope, status, or programme role.

The research object can be a concept, claim, hypothesis, model, dataset, historical reconstruction, value judgment, domain translation, institutional recommendation, or unresolved disagreement. Re-epistemization does not require that every inherited object change. A later inquiry may strengthen the earlier claim, leave it substantially intact, narrow its scope, reveal a latent ambiguity, split it into domain-specific variants, or defeat it. The defining feature is renewed answerability under changed epistemic conditions.

Definition 25.236 (Re-epistemization trigger). A *re-epistemization trigger* is a documented change in the conditions of inquiry that provides a reason to reopen an inherited research object because the change can materially affect its evidential support, conceptual interpretation, evaluative standing, domain scope, or practical consequence.

A trigger should be material rather than merely chronological. The passage of time alone does not require a new judgment. Materiality arises when later conditions alter what can responsibly be observed, inferred, represented, compared, valued, or acted upon. The same discipline also prevents novelty from becoming an automatic source of epistemic authority. A newer dataset, model, method, technology, or normative

Table 25.11: Principal pathways of future re-epistemization in GRE

Pathway	Material change	Primary safeguard
New evidence	Additional observations, archives, testimony, measurements, consequences, or linked records	Separate newly observable evidence from what was available in the earlier epistemic state
New methods	Changed identification, measurement, comparison, interpretation, or formal procedure	Show which result depends on method and preserve comparability with the earlier procedure
New technologies	Changed observability, computation, linkage, simulation, access, or representational capability	Distinguish greater technical capability from stronger substantive validity and record technology-induced selection
New historical positions	Later consequences, temporal distance, altered institutions, or changed category meanings	Reconstruct contemporaneous knowledge and avoid projecting later visibility backward
New domains	Corrections or structures supplied by neighboring fields or newly relevant economic domains	Preserve domain-specific predicates, translation loss, and non-transferable remainder
New normative frameworks	Changed standing, values, duties, harms, rights, or evaluative vocabulary	Distinguish revised evaluation from revised descriptive or causal inference
Reanalysis	New analytical operation on preserved or extended evidence	Record the analytical delta and compare outputs under explicit assumptions
Reinterpretation	New account of meaning, significance, attribution, classification, or programme relevance	Preserve the inferential bridge between evidence and interpretation together with serious alternatives

vocabulary can improve inquiry, but its later date does not establish superiority by itself.

Table 25.11 summarizes the principal pathways developed in this section and the safeguards that keep reopening historically and epistemically disciplined.

Proposition 25.237 (Reconstructive comparison condition). *A GRE re-epistemization claim is strongest when the earlier epistemic state and the later change are both reconstructable enough to identify which part of the resulting confirmation, revision, localization, branching, or defeat is attributable to changed conditions of inquiry.*

Proposition 25.237 links re-epistemization directly to the provenance architecture of Section 25.10. Without an earlier baseline, later inquiry can identify a current conclusion but cannot reliably explain how or why the warranted state changed. With a baseline, theoretical evolution becomes inspectable rather than merely successive.

25.11.1 New Evidence

New evidence is the most direct trigger for reopening an inherited GRE object. Evidence can become available because additional observations accumulate, consequences unfold, archives are opened, records are digitized, datasets are linked, measurements improve, previously excluded testimony enters inquiry, institutions disclose internal processes, or a new comparison case appears. These additions can alter the warrant of earlier claims without changing the historical events to which those claims refer.

Definition 25.238 (Evidential reopening event). An *evidential reopening event* occurs when newly available or newly admissible evidence has a plausible material bearing on the support, scope, interpretation, or defeat conditions of a preserved GRE research object.

The phrase *new evidence* requires care. A source can be newly discovered while describing an old event. A long-horizon outcome can become observable only after sufficient time has passed. A previously available source can become evidentially usable because provenance has been recovered or because a relevant relation to other records has been established. A testimony can become newly admissible when an earlier research design wrongly excluded the speaker's position. These cases change the later evidence set in different ways and can therefore justify different kinds of revision.

Definition 25.239 (Evidential delta record). An *evidential delta record* identifies the evidence available to an earlier inquiry, the evidence added, removed, reclassified, or newly linked in a later inquiry, the reason for the change, and the claims or interpretations whose warrant may consequently differ.

An evidential delta can strengthen as well as weaken an inherited claim. Later observations can show that a proposed mechanism persists across settings, or they can reveal that an apparent regularity depended on an institutional configuration that was temporary. Additional evidence can also leave a claim's direction intact while changing its scale, frequency, mechanism, or domain boundary. Re-epistemization should preserve these differentiated outcomes instead of reducing them to confirmation or refutation.

Later consequences create a particularly important evidential class. A policy, technology, institution, or allocation can have effects that were genuinely unavailable for direct observation at the time of the original analysis. Once those effects become observable, later inquiry can reassess the earlier prediction, causal account, or evaluation. The reassessment should distinguish the epistemic question of what later evidence supports from the historical question of what contemporaneous actors could reasonably have anticipated.

Definition 25.240 (Later-consequence evidence). *Later-consequence evidence* is evidence produced by outcomes, feedbacks, adaptations, path dependencies, or cumulative effects that become observable only after the earlier epistemic state whose claims are being reassessed.

This distinction matters for responsibility and evaluation. Later harm can reveal that an earlier model was incomplete. It does not by itself establish that the omission was culpable or avoidable at the time. Conversely, a preserved warning, ignored counterexample, or available alternative can show that an adverse consequence was more foreseeable than later institutional memory suggests. Provenance therefore

allows re-epistemization to improve retrospective judgment without collapsing hindsight into contemporaneous knowledge.

New evidence can also transform the object of inquiry. A category initially treated as homogeneous may become internally differentiated after disaggregated records are recovered. An institution initially represented through formal rules may require reinterpretation after implementation records or participant accounts become available. In such cases the later inquiry revises more than a parameter estimate; it can revise the relational object to which the earlier claim referred.

Proposition 25.241 (Evidence-sensitive reopening principle). *GRE should reopen a preserved research object when materially relevant new evidence changes the defensible evidential basis of that object, while retaining enough of the earlier evidence state to distinguish later correction from retrospective projection.*

25.11.2 New Methods

Methods determine which relations can be observed, identified, estimated, compared, reconstructed, or interpreted. Later methodological developments can therefore reopen an earlier GRE result even when the underlying records remain unchanged. New causal designs, measurement procedures, archival methods, qualitative protocols, comparative strategies, formal tools, computational techniques, or mixed-method architectures can expose structures that earlier procedures could not resolve.

Definition 25.242 (Methodological reopening event). *A methodological reopening event occurs when a later method changes the feasible identification, measurement, reconstruction, comparison, formal representation, or interpretation of an inherited research object in a way that can materially affect its warranted status.*

Methodological novelty should remain question-relative. A method that improves prediction can be poorly suited to causal identification. A highly parameterized model can fit observations while obscuring the historical constitution of its categories. A new qualitative protocol can recover meanings excluded by a standardized instrument while providing limited population-level inference. GRE's methodological pluralism therefore treats new methods as changes in access conditions rather than as a universal hierarchy of epistemic advancement.

Definition 25.243 (Method-comparison bridge). *A method-comparison bridge records the target object, assumptions, data requirements, inferential purpose, output semantics, and known limitations of two or more methods so that differences in their results can be interpreted without presuming methodological equivalence.*

The bridge is needed because a later method may answer a different question while appearing to replace the earlier one. A new measure can improve reliability while changing the construct represented. A new estimator can reduce bias under assumptions absent from the earlier analysis. A new historical method can shift attention from institutional outcomes to category formation. These developments can be valuable while remaining non-substitutable. Re-epistemization should specify whether the method changes precision, identification, object definition, interpretation, or the question itself.

Method changes can also reveal earlier robustness. If materially different methods with different failure modes converge on a bounded conclusion, the claim can acquire

stronger comparative support. Divergence is equally informative when provenance makes its source traceable. The divergence may arise from data requirements, assumptions, temporal scale, unit of analysis, interpretive framing, or model structure. A programme that preserves methodological disagreement can convert such divergence into a research object rather than treating it as noise to be averaged away.

Definition 25.244 (Method-conditioned claim state). A *method-conditioned claim state* is a version of a claim whose warrant and scope are recorded together with the method-dependent assumptions and access conditions required to support it.

This object is particularly useful when a claim is robust within one analytical mode but unresolved across modes. Historical evidence can support a relational sequence that current quantitative data cannot identify. Quantitative evidence can establish a population pattern whose generative mechanism remains interpretively uncertain. Formal analysis can derive consequences from assumptions whose empirical adequacy remains open. Re-epistemization can preserve these differences rather than forcing them into one evidential scale.

Proposition 25.245 (Methodological non-supersession principle). A *later method should supersede an earlier GRE result only to the extent that the methods address sufficiently comparable objects and inferential purposes and the later method provides stronger warrant for the relevant claim; methodological novelty alone does not establish substantive supersession.*

25.11.3 New Technologies

Technological change can alter the practical frontier of inquiry. Digitization can make dispersed archives searchable; sensors can increase temporal or spatial resolution; secure computation can permit analysis that privacy constraints previously blocked; simulation can explore regimes inaccessible to direct experiment; language technologies can assist multilingual comparison; and improved compute can make previously infeasible models tractable. These developments can materially change what a later GRE inquiry can examine.

Definition 25.246 (Technological epistemic affordance). A *technological epistemic affordance* is a technology-dependent capacity to observe, preserve, search, link, compute, simulate, represent, communicate, or inspect research material that changes the feasible epistemic operations available to an inquiry.

Technological affordance differs from evidential warrant. Greater resolution can expose new patterns, but it can also amplify artifacts. Larger corpora can widen coverage while inheriting platform selection, documentation gaps, unequal digitization, or systematic absence. Automated extraction can accelerate analysis while introducing classification errors that are difficult to detect at scale. Computational tractability can make a model executable without making its assumptions more appropriate. Re-epistemization should therefore record how technology changes access and where it creates new dependencies.

Definition 25.247 (Technology-conditioned evidence). A *technology-conditioned evidence profile* records which observations, transformations, linkages, representations, or analytical operations became possible through a specified technological configuration, together with the configuration's selection effects, failure modes, dependencies, and access constraints.

Artificial intelligence makes this distinction especially important. AI-assisted coding, translation, retrieval, classification, synthesis, or simulation can expand the volume and heterogeneity of material a researcher can engage. It can also reshape the pathway by which evidence reaches the researcher. Model training histories, retrieval coverage, interface design, prompting, system updates, confidence calibration, and human review can become part of the evidential and methodological provenance. A later AI system can reopen an earlier archive, yet the system's output remains an epistemically mediated representation whose reliability depends on the task and validation procedure.

Technologies can additionally transform the object being studied. Digital platforms, automated decision systems, new payment infrastructures, and AI-mediated institutions can generate economic relations that did not previously exist in the same form. Reopening an earlier GRE concept under such conditions may require distinguishing two questions: whether new technology reveals an old relation more clearly, and whether it creates a materially new relational configuration. The first supports re-analysis of a preserved object. The second can require concept or domain revision.

Definition 25.248 (Technological object-change test). *A technological object-change test asks whether a later technology primarily changes epistemic access to an inherited economic object or materially changes the relational object itself through new actors, interfaces, dependencies, capacities, constraints, or modes of value circulation.*

The distinction prevents technological novelty from being treated only as an improved research instrument when it has become constitutive of the economic configuration. It also prevents the reverse mistake of declaring a wholly new object whenever a better instrument reveals a structure that was already present.

Proposition 25.249 (Technology-mediated reopening principle). *GRE should treat new technologies as potential re-epistemization triggers when they materially alter epistemic affordances or the economic object itself, while preserving the distinction between improved access, technology-induced evidence selection, and genuine transformation of the relations under study.*

25.11.4 New Historical Positions

A research programme occupies historical time. Later researchers inherit outcomes, institutions, vocabularies, political arrangements, technologies, and comparative cases unavailable to earlier inquiry. Temporal distance can disclose long-horizon consequences, reveal the durability or transience of a mechanism, alter the salience of a category, and create new possibilities for comparison. Future re-epistemization therefore depends partly on the changing historical position from which inquiry occurs.

Definition 25.250 (Historical-position shift). *A historical-position shift is a change in the temporal and institutional location of inquiry that materially alters the consequences visible, comparison cases available, categories intelligible, records accessible, or practical questions through which an inherited research object can be examined.*

Historical position differs from new evidence alone. Later inquiry may possess many of the same records while understanding their significance differently because institutions have evolved or a once-local pattern has become historically consequen-

tial. An early institutional arrangement can appear marginal at inception and later become a template reproduced across jurisdictions. A temporary emergency measure can become infrastructurally entrenched. A concept can acquire new political or legal meaning. The later position changes the relational field in which earlier evidence is interpreted.

This creates a retrospective asymmetry. Later researchers know at least some outcomes that earlier researchers did not. That advantage can improve explanation, yet it can also generate presentism and inevitability narratives. A successful institution can make its emergence appear predictable; a failed project can make warning signs seem obvious; a later category can be projected into a period in which actors organized experience differently. Re-epistemization should therefore preserve the earlier horizon of alternatives and uncertainty.

Definition 25.251 (Contemporaneous epistemic baseline). A *contemporaneous epistemic baseline* reconstructs, as far as the surviving record permits, the evidence, concepts, methods, institutional knowledge, feasible alternatives, and uncertainties available at the historical position from which an earlier claim or decision was formed.

The baseline does not prohibit later judgment. It makes the object of judgment more precise. A later inquiry can conclude that an earlier claim was unsupported by evidence available at the time, that it was reasonable but later defeated, that a neglected warning was already accessible, or that the question itself could not yet be formulated in its later form. These are materially different historical conclusions.

New historical positions can also change the practical relevance of GRE concepts. A concept developed around one technological, institutional, or geopolitical configuration may require revision when the relations it describes are reorganized. Historical revisability from Section 25.7 therefore has an evidential complement: conceptual history and programme history should be revisited when later conditions make inherited classifications inadequate.

Definition 25.252 (Retrospective warrant distinction). The *retrospective warrant distinction* separates a later judgment about what current evidence supports from a historical judgment about what an earlier epistemic position could reasonably support under the evidence and concepts then available.

Proposition 25.253 (Historically situated re-epistemization principle). *Future GRE inquiry should use later historical position to revise explanation and evaluation where warranted while preserving the contemporaneous epistemic baseline needed to distinguish later visibility from earlier knowability.*

25.11.5 New Domains

A later domain of inquiry can reopen an economic claim by revealing relations, predicates, mechanisms, or constraints that the original economic analysis did not represent adequately. Chapter 23 developed interfaces with history, governance, law, political theory, education, ecology, artificial-intelligence studies, social theory, and aesthetics. Future domains may add further interfaces. Re-epistemization occurs when such domain knowledge changes what GRE can responsibly claim about an inherited economic object.

Definition 25.254 (Domain-triggered re-epistemization). *Domain-triggered re-epistemization* is the reopening of a GRE object because evidence, concepts, mech-

anisms, or validity conditions developed in another domain materially alter the economic object's description, explanation, evaluation, or scope.

The process is bidirectional. A legal development can alter the institutional predicates under which an economic relation exists. Historical reconstruction can show that a supposedly general economic category was constituted through a particular sequence. Ecological evidence can reveal material dependencies excluded from a value account. Educational research can alter assumptions about capability formation. AI studies can revise the technical object represented in an economic model of automation. These corrections can enter GRE without requiring the neighboring domain to become economics.

Definition 25.255 (Domain correction return). A *domain correction return* is a provenance-preserving result from a neighboring inquiry that identifies a GRE claim, concept, model, translation, or application requiring confirmation, qualification, reinterpretation, branching, or revision because of domain-specific evidence or reasoning.

A correction return should preserve the predicate under which it has authority. A legal determination can settle the content of an authoritative legal rule without settling the economic consequences of implementation. An ecological model can constrain claims about material regeneration without deciding a distributive principle. A historical reconstruction can defeat a timeless origin story without providing a complete contemporary causal estimate. Cross-domain re-epistemization therefore depends on typed jurisdiction over claims.

New domains can also generate genuinely new economic questions. An interface can reveal a relation that was previously outside GRE's active object set but has economic consequences once translated. Such expansion should remain distinguishable from retroactively claiming that GRE already contained the domain insight. Provenance should show when the new object entered the programme and which concepts required alteration to accommodate it.

Definition 25.256 (Domain-expansion event). A *domain-expansion event* occurs when a neighboring field or newly salient substantive domain introduces an economic question, relation, or constraint that warrants extending GRE's active research objects while preserving the independent domain knowledge on which the extension depends.

Section 580 develops GRE's continuing openness to domain evidence in greater detail. The present point is narrower: domain evidence can act retrospectively on inherited GRE states. Cross-domain learning therefore provides a mechanism of programme correction as well as a source of future research questions.

Proposition 25.257 (Domain-correction principle). *GRE should permit neighboring domains to reopen inherited economic claims when their domain-specific evidence or reasoning materially reaches those claims, while preserving domain predicates, translation losses, jurisdictional limits, and non-transferable remainders.*

25.11.6 New Normative Frameworks

Normative inquiry also changes historically. New accounts of standing, rights, duties, capability, recognition, care, ecological responsibility, intergenerational obligation, participation, or justice can alter how an inherited economic arrangement is evalu-

ated. A later normative framework can reveal harms, exclusions, dependencies, or value conflicts that an earlier programme state did not represent adequately. Such developments can justify re-epistemization even when the underlying descriptive evidence changes little.

Definition 25.258 (Normative reopening event). A *normative reopening event* occurs when a materially changed evaluative framework alters the relevant subjects, values, standing relations, duties, harms, rights, comparison criteria, or justificatory burdens applied to a preserved GRE object.

Normative reopening should remain analytically typed. A new evaluative framework can change the judgment assigned to an economic arrangement without changing the descriptive claim that the arrangement existed or the causal claim about how it operated. In other cases the normative change can also expose descriptive omissions. If earlier data collection excluded a class of affected subjects because they lacked recognized standing, later normative correction can motivate new evidence collection and thereby alter both evaluation and empirical description.

Definition 25.259 (Normative-description record). A *normative-descriptive separation record* identifies which components of a re-epistemized conclusion arise from changed evaluative premises and which arise from changed descriptive, causal, historical, or evidential claims.

This separation protects against two errors. One is to present a changed moral judgment as though new empirical facts alone produced it. The other is to treat normative revision as merely subjective preference and thereby overlook how altered standing or value recognition can change what evidence should have been gathered in the first place. GRE's value plurality requires the programme to record both the normative framework and the evidential consequences of its adoption.

Normative re-epistemization can also reopen the programme's own concepts. A definition of participation can prove too procedural when later justice analysis shows that effective standing depended on capability or access. A value framework can require distinction among benefits that were previously aggregated. A power analysis can require attention to subjects whose vulnerability was omitted. These revisions belong to programme history and should remain attributable to the normative arguments that motivated them.

Definition 25.260 (Normative inheritance test). A *normative inheritance test* asks whether a later GRE evaluation retains, revises, supplements, or rejects the evaluative premises of an earlier programme state and records the consequences of that choice for standing, value comparison, justice, and practical recommendation.

Later normative frameworks need not be assumed superior simply because they are later. They remain open to argument, contestation, cross-cultural criticism, and future revision. Re-epistemization records the change in evaluative architecture and the reasons for it; it does not convert historical sequence into moral proof.

Proposition 25.261 (Normative re-epistemization principle). *GRE should permit later normative frameworks to reopen inherited evaluations and, where warranted, the categories of evidence and standing on which those evaluations depend, while preserving the distinction among normative revision, descriptive correction, and historical judgment.*

25.11.7 Reanalysis

Reanalysis is an operational pathway through which several preceding triggers become research practice. A preserved dataset can be recomputed with a new estimator; an archive can be recoded under a revised classification; a model can be rerun with altered assumptions; a qualitative corpus can be reexamined using a different sampling or coding procedure; a historical sequence can be reconstructed after records are linked; or a comparative analysis can be extended to cases unavailable in the earlier study. The central object is a change in analytical operation whose effects can be compared with a preserved earlier result.

Definition 25.262 (GRE reanalysis). *GRE reanalysis* is a provenance-preserving repetition or reconstruction of an earlier analytical task in which one or more evidence, measurement, method, assumption, model, sample, classification, or computational conditions are deliberately changed and the consequences for the inherited result are assessed.

Reanalysis differs from replication. Replication, developed in Section 25.9, asks whether an earlier result can be reproduced or supported under specified repetition conditions. Reanalysis intentionally changes one or more analytical conditions in order to learn how the result depends on them. A successful replication can therefore precede reanalysis, but neither is a prerequisite for every case. Historical inquiry may reanalyze a source corpus that cannot be replicated as a past collection event. Sensitive data can support controlled reanalysis even when public reproduction is impossible.

Definition 25.263 (Analytical delta specification). An *analytical delta specification* records the differences between the earlier and later analytical configurations, including changes in data, sample, categories, assumptions, methods, parameters, software, comparison sets, or inferential targets that can materially affect the result.

The delta specification prevents a later output from being compared with an earlier output as though only one thing had changed when several dimensions moved simultaneously. When feasible, staged reanalysis can vary conditions separately or in documented combinations. The objective is not always causal isolation of each analytical choice; it is reconstructable attribution of why later results differ enough to inform programme revision.

Reanalysis can produce several programme outcomes. It can demonstrate robustness across alternative specifications. It can localize a result to one sample or institutional setting. It can show sensitivity to a classification choice. It can reveal that an earlier computational approximation materially shaped the conclusion. It can also produce a new unresolved disagreement when several defensible analyses remain incompatible. Such disagreement belongs in the programme record rather than being hidden by selecting the most convenient specification.

Definition 25.264 (Reanalysis disposition). A *reanalysis disposition* classifies the effect of a reanalysis on an inherited research object as, for example, corroboration, precision change, scope localization, mechanism revision, specification sensitivity, branching, unresolved conflict, or defeat, together with the analytical delta that produced the classification.

Reanalysis is particularly valuable for GRE because many of its objects are relational and historically conditioned. A result can depend on network boundary, temporal window, institutional classification, value representation, scale, or the relation

chosen as analytically focal. Reanalysis can expose these dependencies and thereby improve the scope statement of the original claim.

Proposition 25.265 (Reanalysis traceability condition). *A GRE reanalysis contributes to cumulative programme knowledge when the analytical delta and resulting claim-state change are traceable enough to show which dependencies of the inherited result have been strengthened, weakened, localized, or left unresolved.*

25.11.8 Reinterpretation

Reinterpretation concerns a different pathway. An inherited body of evidence can remain substantially unchanged while its meaning, explanatory significance, attribution, classification, or programme relevance changes. A historical archive can acquire a different interpretation after category provenance is reconstructed. A quantitative association can receive a different relational explanation after institutional evidence becomes available. A policy record can be reevaluated when affected-party testimony alters the understanding of participation. A formal model can remain mathematically valid while its economic interpretation is narrowed.

Definition 25.266 (GRE reinterpretation). *GRE reinterpretation is a provenance-preserving revision of the meaning, explanatory significance, attribution, classification, normative significance, or programme role assigned to an inherited research object under changed conceptual, historical, relational, domain, or evaluative conditions.*

Reinterpretation should preserve the inferential bridge between evidence and meaning. Evidence rarely carries a complete theoretical interpretation by itself. Categories, background assumptions, comparison classes, causal narratives, value frameworks, and domain knowledge mediate the move from record to meaning. Future inquiry can revise those mediating structures while retaining much of the underlying record.

Definition 25.267 (Interpretive delta record). *An interpretive delta record identifies the earlier and later interpretations of a substantially shared evidential object, the conceptual or contextual changes that motivate the later interpretation, the evidence that discriminates between them where available, and the programme consequences of retaining, regionalizing, or retiring either interpretation.*

The interpretive delta complements the branch records developed in Section 25.10. A dormant interpretation can regain standing when later evidence or concepts change. A previously dominant interpretation can become one regional account among several. Two interpretations can also remain jointly viable because they answer different questions or operate at different scales. Re-epistemization should therefore support revival and differentiation as well as replacement.

Reinterpretation has a special relation to programme identity. Sections 25.3 and 25.8 distinguished core commitments from plural formulations. A sufficiently deep reinterpretation may preserve GRE's relational and generative problem orientation while changing a formalism, value theory, or account of power. Another reinterpretation may reject enough core commitments that it is better represented as a successor programme. Provenance allows that boundary to be argued historically rather than enforced by vocabulary alone.

Definition 25.268 (Programme-level re-epistemization portfolio). *A programme-level*

re-epistemization portfolio is a versioned collection of reopened GRE objects, their triggers, preserved earlier states, evidential and interpretive deltas, reanalysis results, domain corrections, normative revisions, dispositions, unresolved alternatives, and resulting changes to programme dependencies.

The portfolio turns future revision into cumulative programme memory. It can show which claims have repeatedly survived new evidence, which concepts remain method-sensitive, which interpretations have branched, which negative results became informative after technology changed, and which domain corrections forced architectural revision. It can also identify research objects that remain open because the necessary evidence or discriminating test is still unavailable.

Proposition 25.269 (Reanalysis–reinterpretation distinction). *GRE should preserve reanalysis and reinterpretation as distinct but combinable re-epistemization pathways because changes in analytical operation do not determine changes in meaning, while changes in meaning can occur without materially different analytical operations.*

Proposition 25.270 (Re-epistemization condition). *GRE remains re-epistemizable when preserved earlier states can be reopened under materially changed epistemic conditions, revised conclusions can be traced to identifiable evidential, methodological, technological, historical, domain, normative, analytical, or interpretive changes, and the resulting programme state retains both its new warrant and the lineage of the state it supersedes, regionalizes, or leaves unresolved.*

Future re-epistemization therefore gives preservation an active programme function. Research memory is valuable because later communities can form new epistemic relations with inherited objects. New evidence can revise warrant; new methods can alter access to mechanisms; new technologies can widen observation and computation; new historical positions can disclose consequences and category change; new domains can return corrections; new normative frameworks can alter standing and evaluation; reanalysis can test dependency on analytical choices; and reinterpretation can change meaning without erasing the evidential past. None of these pathways guarantees progress in advance. Their value lies in making later inquiry capable of correcting, differentiating, or reaffirming inherited GRE states through reconstructable comparison.

The next section turns from the general mechanisms of reopening to a continuing source of correction: domain evidence. Section 580 examines how GRE should remain answerable to evidence emerging from economics and neighboring domains while preserving the domain-specific predicates and limits that make such evidence interpretable.

25.12 Openness to Domain Evidence

Section 25.11 developed future re-epistemization as a general process through which preserved GRE objects can be reopened when evidence, methods, technologies, historical positions, domains, normative frameworks, analytical operations, or interpretations materially change. The present section specifies one source of such reopening in greater detail: evidence generated within domains whose objects, methods, institutional settings, and validity conditions are partly distinct from GRE. Its role is to establish an ingress architecture through which economics, history, governance, law, education, ecology, artificial-intelligence studies, and other fields can correct GRE with-

out being reduced to GRE vocabulary. Its objective is to identify what each domain can contribute, what translation work is required, and which source-domain predicates should remain attached to the evidence after it enters a GRE argument. The discussion is interface-based and provenance-sensitive. Domain evidence is admitted through reconstructable relevance relations, while differences in scale, category, authority, method, and normative standing remain available for later contestation.

Openness to domain evidence is stronger than a willingness to cite neighboring literatures. A research programme is substantively open when findings produced elsewhere can alter the warrant, scope, interpretation, or architecture of its own claims. Such openness does not require theoretical identity. A legal judgment, ecological threshold, historical archive, administrative record, educational trajectory, economic estimate, or AI deployment audit can constrain a GRE claim even when the source domain organizes its objects through concepts that GRE does not reproduce.

Definition 25.271 (Domain evidence interface). A *domain evidence interface* is a documented relation between an evidential object produced or warranted within a source domain and a GRE research object whose support, scope, interpretation, assumptions, or practical implications can be materially affected by that evidence.

The interface contains more than a thematic resemblance. It identifies what the source object is, how it was produced, the validity conditions recognized within the source domain, the GRE object to which it is relevant, and the inferential path connecting the two. The interface can remain partial. Evidence can bear on one premise of a GRE argument without validating the rest of the framework from which that premise was drawn.

Definition 25.272 (Domain evidence packet). A *domain evidence packet* records the source-domain object, provenance, method of production, relevant validity conditions, temporal and spatial scope, target GRE object, relevance relation, translation operations, known remainder, and possible revision consequences needed for a domain contribution to enter GRE in reconstructable form.

A domain evidence packet does not convert every contribution into the same evidential format. Its purpose is to preserve heterogeneity while making the correction relation explicit. Some packets will contain statistical estimates; others will contain archival sequences, doctrinal materials, administrative process evidence, qualitative testimony, biophysical measurements, or system-version-specific technical observations. GRE can compare their programme consequences without pretending that their warrants are identical.

Table 25.12 summarizes the principal domain interfaces developed in this section.

Proposition 25.273 (Domain-evidence openness condition). *GRE is substantively open to a source domain when evidence warranted within that domain can revise a relevant GRE object through a reconstructable interface without requiring the source evidence to lose the predicates on which its original warrant depends.*

Proposition 25.273 makes openness asymmetric in a useful sense. A source domain need not accept GRE in order for its evidence to constrain GRE. The burden falls on the GRE argument to show why the evidence is relevant, which parts of the source warrant survive translation, and where residual uncertainty remains. Domain evidence thereby functions as an external correction channel rather than as an annex to programme vocabulary.

Table 25.12: Principal domain-evidence interfaces for GRE

Source domain	Characteristic evidential contribution	Primary preservation requirement
Economics	Prices, quantities, organizations, incentives, institutions, distributions, causal estimates, expectations, and behavioral responses	Retain model, identification, measurement, market, institutional, and population conditions
History	Archives, sequences, trajectories, category change, institutional emergence, long-run consequences, and historically situated testimony	Retain temporal position, source formation, sequence, category provenance, and contemporaneous alternatives
Governance	Administrative records, implementation processes, participation, organizational capacity, policy feedback, and street-level practice	Retain implementation setting, authority structure, affected populations, discretion, and feedback conditions
Law	Legal texts, judgments, procedures, rights, duties, status categories, jurisdiction, enforcement, and legal practice	Retain jurisdiction, temporal validity, source hierarchy, interpretive status, and law-in-practice distinctions
Education	Learning trajectories, capability formation, institutional selection, curricula, credentials, participation, and pedagogical environments	Retain learner population, educational setting, measurement construct, selection process, and longitudinal horizon
Ecology	Biophysical stocks and flows, ecosystem states, material constraints, thresholds, dependencies, and long-horizon effects	Retain ecological scale, measurement system, uncertainty, irreversibility, and non-economic remainder
AI studies	Benchmarks, audits, deployment records, failure modes, human–AI interaction, labor effects, system behavior, and versioned capabilities	Retain system version, task, deployment context, access conditions, evaluation design, and sociotechnical mediation
Other domains	Domain-specific evidence capable of correcting a GRE object through an explicit relevance relation	Retain the source domain’s own validity conditions and specify translation limits before generalization

25.12.1 Economics

Economics is the nearest evidential domain for GRE because GRE is itself proposed as an economic research programme. This proximity increases rather than reduces the need for explicit correction. Established and emerging economic research can test whether GRE distinctions add explanatory value, whether proposed mechanisms survive empirical scrutiny, whether relational accounts reproduce already known

results under new terminology, and whether GRE neglects mechanisms that conventional economic analysis identifies more precisely.

Definition 25.274 (Economic-domain correction event). An *economic-domain correction event* occurs when economic evidence or analysis materially changes the warranted status, scope, mechanism, measurement, comparative relevance, or practical implication of a GRE research object.

Economic evidence can enter through many forms: price and quantity data, household and firm behavior, labor-market outcomes, organizational records, distributional measures, national accounts, experiments, quasi-experimental designs, surveys, market design, institutional comparison, behavioral studies, and theoretical results whose assumptions are explicit enough to compare with GRE claims. The evidential contribution depends on the object. A causal estimate can constrain a proposed mechanism; a measurement study can reveal that a GRE concept is poorly operationalized; a theoretical model can expose an omitted equilibrium effect; a distributional analysis can show that a purportedly generative intervention reallocates risk or surplus in ways the initial GRE account overlooked.

Definition 25.275 (Economic evidential compatibility record). An *economic evidential compatibility record* identifies the GRE claim under examination, the economic evidence or model brought to bear on it, the relevant population and institutional setting, the identification or inferential assumptions where applicable, the dimensions of agreement or conflict, and the resulting programme disposition.

Compatibility should be assessed at the level actually tested. A result concerning one labor market does not establish a general proposition about labor relations. An experimental treatment effect does not by itself establish the long-run generative architecture of the intervention. A macroeconomic regularity does not automatically determine its micro-relational mechanism. Conversely, a GRE relational reconstruction cannot dismiss a robust economic finding merely because the finding was produced within a different conceptual vocabulary.

Proposition 25.276 (Economic evidence priority principle). *When a GRE claim makes an empirically addressable economic assertion, relevant economic evidence should constrain that assertion at the level supported by the evidence, while broader relational or generative interpretation remains separately arguable.*

This principle protects GRE from becoming insulated by conceptual novelty. Relational attention can reorganize an economic question, but it does not create exemption from economic evidence. The productive relation is reciprocal: GRE can identify variables, relations, timescales, and value forms that deserve economic study, while economics can confirm, localize, revise, or defeat the resulting claims.

Proposition 25.277 (Economic non-redundancy test). *A GRE contribution to an economic problem gains programme significance when its relational or generative distinctions change the question, evidence requirements, mechanism account, scope statement, or practical implication in ways that remain distinguishable from an equivalent reformulation of already sufficient economic analysis.*

The non-redundancy test is deliberately demanding. GRE can remain useful when it offers synthesis across mechanisms or timescales, but the programme should preserve the possibility that an existing economic framework already answers a particular question more efficiently. Such cases refine GRE's domain of contribution rather than threatening programme identity.

25.12.2 History

Historical evidence is indispensable to a programme that treats economic subjects, categories, institutions, relations, and capacities as historically constituted. History supplies more than illustrative background. Archives, administrative records, correspondence, material traces, oral histories, institutional sequences, changing classifications, and long-run trajectories can determine whether a proposed relation existed, when it emerged, which alternatives were available, and how later structures inherited earlier decisions.

Definition 25.278 (Historical correction packet). A *historical correction packet* records the sources, source-formation conditions, temporal position, sequence claims, category provenance, contemporaneous alternatives, and interpretive uncertainties through which historical evidence bears on a GRE object.

Historical evidence often changes the identity of the object under study. Terms such as market, household, worker, property, welfare, firm, public, private, or education can refer to institutions whose relational constitution changes over time. A dataset that carries a stable column name across decades can therefore conceal a changing category. GRE's interest in historical generativity makes such category drift theoretically consequential rather than merely terminological.

Definition 25.279 (Historical validity horizon). A *historical validity horizon* is the temporal and institutional range within which a GRE claim is supported by the historical configuration on which its mechanism, categories, or comparison depend.

A validity horizon can be narrow or extended. Its purpose is to make historical scope explicit. A mechanism observed under a particular monetary regime, property arrangement, administrative technology, demographic structure, or geopolitical order may persist after that configuration changes, but persistence requires evidence. Historical continuity should be demonstrated rather than inferred from vocabulary alone.

Proposition 25.280 (Historical sequence constraint). A *GRE mechanism that depends on an asserted sequence of institutional, relational, or economic formation should remain revisable by historical evidence concerning chronology, category change, contemporaneous alternatives, and path dependence.*

Historical evidence can also correct retrospective necessity. Outcomes that appear structurally inevitable after the fact may have depended on contingent decisions, unrealized alternatives, or temporary coalitions. Preserving these alternatives matters for GRE because generativity concerns possible continuations as well as realized outcomes.

Proposition 25.281 (Retrospective contingency principle). *When historical evidence supports multiple contemporaneously viable pathways, GRE should represent later stabilization as historically generated rather than treating the realized path as evidence that competing paths were structurally unavailable.*

This principle links historical correction to future openness. Recovering unrealized or suppressed possibilities can change the interpretation of present constraints and can reveal which apparent necessities are products of inherited institutions rather than fixed features of economic life.

25.12.3 Governance

Governance evidence bears on the organization, implementation, mediation, and feedback of collective action. GRE discussions of intervention, participation, institutional capacity, power, and relational consequences require evidence about how governing arrangements operate after formal decisions are made. Administrative records, implementation studies, organizational processes, service-delivery data, consultation records, complaints, audits, local practice, and affected-party testimony can reveal the difference between an announced policy and the relations through which it is enacted.

Definition 25.282 (Implementation-relational evidence). *Implementation-relational evidence* is evidence concerning the organizational, interpersonal, procedural, infrastructural, and discretionary relations through which a governing decision is translated into experienced effects.

Implementation-relational evidence is especially important when formal policy instruments are similar but outcomes diverge across places or populations. Variation can arise through administrative capacity, frontline discretion, access barriers, local trust, information asymmetry, institutional coordination, enforcement, or unequal ability to contest decisions. These mediating relations can be part of the causal object rather than noise around policy design.

Definition 25.283 (Governance mediation record). A *governance mediation record* identifies a governing intervention, its formal authority, implementing organizations, relevant discretionary points, participation channels, affected populations, observed implementation pathways, feedback processes, and divergences between formal design and realized practice.

Governance evidence can also reveal recursive effects. An intervention changes incentives and services, but it can also alter trust, organizational routines, classification practices, expectations, political participation, or the capacity of groups to make later claims. Such feedback is directly relevant to GRE's concern with generative consequences.

Proposition 25.284 (Implementation correction principle). *A GRE evaluation of a governing intervention should remain revisable by evidence concerning implementation relations and feedback whenever those relations materially mediate the intervention's realized distributional, generative, participatory, or institutional effects.*

Governance evidence does not automatically determine normative judgment. Administrative efficiency can coexist with exclusion; broad participation can coexist with weak capacity; rapid implementation can produce irreversible harms; and procedural compliance can coexist with relational domination. The evidence interface should therefore preserve the distinction between observed governing performance and the evaluative framework used to judge it.

Proposition 25.285 (Governance evidence separation principle). *GRE should distinguish evidence about how governance operates from the normative criteria used to evaluate that operation, while permitting empirical findings about participation, burden, capability, and power to reopen the adequacy of the evaluative framework itself.*

25.12.4 Law

Law supplies evidence about formally constituted rights, duties, powers, statuses, procedures, jurisdictions, remedies, prohibitions, authorizations, and institutional competencies. These legal relations can shape economic possibilities directly. They can determine who can own, contract, inherit, organize, work, claim benefits, access procedures, challenge administrative action, or obtain remedies. GRE therefore requires a legal evidence interface that preserves the specificity of legal authority and interpretation.

Definition 25.286 (Juridical evidence object). *A juridical evidence object is a legally situated source or practice whose evidential significance depends on jurisdiction, temporal validity, source type, institutional authority, procedural posture, interpretive status, or enforcement context.*

Legal texts should not be treated as interchangeable statements. A constitution, statute, regulation, judgment, administrative guidance, contract, customary practice, and scholarly interpretation can occupy different positions in a legal order. The relevance of each source also depends on time and jurisdiction. A GRE analysis that extracts a legal category while dropping these conditions can transform a legally specific relation into an inaccurate social abstraction.

Definition 25.287 (Legal-relational evidence packet). *A legal-relational evidence packet records the juridical source, jurisdiction, relevant date, source hierarchy or authority, interpretive posture, legally constituted relation, enforcement or implementation context where material, and the GRE object whose analysis may be revised by that legal configuration.*

Law can be constitutive as well as regulatory. Legal categories can participate in producing firms, property forms, contractual capacities, public authorities, family statuses, financial instruments, and institutional boundaries. Evidence of such constitution can correct GRE accounts that treat these objects as prior to the legal relations that partly generate them.

Proposition 25.288 (Legal constitution principle). *When a GRE economic object depends materially on legal status, authority, entitlement, procedure, or enforceability, the relevant legal relations should enter the account as constitutive conditions rather than as external context alone.*

Law in formal sources and law in experienced practice can also diverge. A formally available right may be difficult to exercise because of cost, information, procedure, retaliation risk, administrative delay, or unequal representation. GRE can therefore use empirical legal and governance evidence together while preserving their distinct claims.

Proposition 25.289 (Legal source specificity principle). *The programme consequence of legal evidence should be limited to the authority, jurisdiction, temporal scope, interpretive status, and practical realization supported by the source rather than generalized from the mere existence of legal language.*

25.12.5 Education

Education provides evidence concerning the formation, distribution, recognition, and conversion of capabilities across time. GRE's interest in generative capacity makes education especially important because educational processes can alter what subjects

are able to learn, produce, interpret, contest, coordinate, and transmit later. Educational evidence includes learning trajectories, classroom practice, institutional selection, curricula, credentials, peer relations, teacher capacity, access conditions, participation, and longer-run transitions into work, civic life, or further learning.

Definition 25.290 (Capability evidence). *Educational capability-formation evidence* is evidence concerning changes in learners' knowledge, skills, interpretive resources, relational capacities, opportunities, recognized credentials, or subsequent action possibilities that can be attributed, with stated uncertainty, to educational environments or processes.

Capability formation should not be reduced to a single observable proxy. Test scores, credentials, employment outcomes, earnings, participation, persistence, creativity, social learning, or later educational access can each illuminate particular dimensions while leaving others unmeasured. GRE's value plurality therefore creates an obligation to specify which educational capability is being represented and which dimensions remain outside the measurement.

Definition 25.291 (Educational conversion record). An *educational conversion record* traces how an educational resource or experience is converted, under specified institutional and relational conditions, into one or more later capabilities, recognitions, opportunities, constraints, or economic outcomes, including observed barriers to conversion.

Selection is a major source of evidential difficulty. Educational institutions sort as well as teach. Access, tracking, peer composition, family resources, language, disability accommodation, geographic location, institutional prestige, and prior attainment can shape both educational experience and later outcomes. A GRE interpretation that treats the observed output as direct evidence of educational generation can therefore confuse formation with selection or recognition.

Proposition 25.292 (Educational attribution principle). *GRE claims about educational generativity should distinguish evidence of capability formation from selection, credential recognition, institutional sorting, and later conversion conditions whenever those processes can materially account for the observed outcome.*

Educational evidence also extends the temporal horizon of economic analysis. Some educational effects emerge only after later opportunities, institutions, or relationships permit a capability to be exercised. Others decay when environments do not support use. Longitudinal evidence can therefore test whether a capability is generated, sustained, converted, or foreclosed across subsequent stages.

Proposition 25.293 (Educational horizon principle). *The programme significance of educational evidence increases when the evidential horizon is matched to the capability or conversion claim, so that immediate performance, durable formation, later opportunity, and long-run relational consequence are not treated as equivalent outcomes.*

25.12.6 Ecology

Ecological evidence can impose constraints on economic analysis that cannot be adequately represented as preferences, prices, or monetary values alone. Biophysical stocks and flows, ecosystem states, material throughput, energy requirements, spatial dependencies, biodiversity conditions, thresholds, recovery times, and irreversible losses can determine whether an economic trajectory is feasible or whether its ap-

parent value generation depends on degrading conditions of future reproduction.

Definition 25.294 (Biophysical constraint evidence). *Biophysical constraint evidence* is empirically grounded information about material, energetic, ecological, spatial, or temporal conditions that bound, enable, degrade, or transform the feasible operation and continuation of an economic process.

Such evidence can enter GRE even when no agreed monetary conversion exists. A watershed limit, soil condition, habitat dependency, emissions pathway, or ecosystem recovery time can constrain a project without first being reduced to a common value metric. The economic relevance arises through dependence and consequence, not solely through exchange value.

Definition 25.295 (Ecological dependence record). An *ecological dependence record* identifies the economic process under study, the ecological systems or material conditions on which it depends or acts, the relevant scale and time horizon, the evidential measures and uncertainties, potential thresholds or irreversibilities, and the GRE claims affected by those dependencies.

Scale is especially important. An activity can appear sustainable within one organizational boundary while shifting extraction, waste, risk, or ecological burden elsewhere. Local recovery can coexist with deterioration at a larger scale. Conversely, a global aggregate can conceal place-specific dependencies and unequal exposure. GRE's relational approach can help trace these couplings, but ecological evidence determines the substantive biophysical content of the relation.

Proposition 25.296 (Ecological non-conversion principle). *Ecological evidence can constrain a GRE economic claim without first being converted into a monetary or otherwise commensurable value measure when the evidence bears directly on feasibility, dependence, threshold, irreversibility, or reproduction conditions.*

Ecological findings also carry uncertainty. Threshold locations, recovery dynamics, interacting systems, and future responses can be incompletely known. Uncertainty does not eliminate evidential relevance; it changes the form of responsible inference and may increase the importance of reversibility, monitoring, and option preservation.

Proposition 25.297 (Ecological uncertainty principle). *GRE should preserve ecological uncertainty in the claim state when uncertain biophysical conditions materially affect feasibility, reversibility, burden distribution, or future generative capacity, rather than replacing that uncertainty with unwarranted point estimates for analytical convenience.*

25.12.7 Artificial Intelligence

Artificial-intelligence evidence is unusually dynamic because the technical object, deployment environment, access conditions, and surrounding institutional practices can change rapidly. GRE's analysis of AI-era capability asymmetry therefore requires evidence that is versioned, task-specific, deployment-sensitive, and sociotechnically situated. Benchmarks, controlled evaluations, red-team findings, audits, deployment logs, user studies, labor outcomes, organizational adoption records, incident reports, human–AI interaction evidence, and longitudinal capability measurements can each address different parts of the problem.

Definition 25.298 (AI-conditioned evidence). *AI-conditioned evidence* is evidence

whose interpretation depends materially on the identity and version of an AI system, the task and evaluation procedure, access and tool conditions, user or organizational context, deployment configuration, and relevant human or institutional mediation.

A capability demonstrated under one evaluation condition does not automatically establish capability in another. Benchmark performance can differ from reliable deployment. Model access through an interface can differ from API access with tools or retrieval. Organizational outcomes can depend on training, workflow redesign, oversight, incentives, complementary expertise, and the distribution of authority around the system. GRE should therefore resist treating an AI model as an isolated actor when the observed economic effect belongs to a coupled sociotechnical arrangement.

Definition 25.299 (AI evidence version record). *An AI evidence version record identifies the evaluated system and version where available, evaluation or deployment date, task, access configuration, tools, comparison baseline, user population or organization, measurement procedure, observed outcome, and conditions under which the evidence may cease to transport to later systems or settings.*

Rapid technical change creates a distinctive re-epistemization problem. Evidence can become historically informative without remaining current for capability assessment. A finding that a system class could not perform a task at one date can later document the speed of capability change even after it ceases to describe current systems. Preservation should therefore distinguish present applicability from historical evidential value.

Proposition 25.300 (AI version-dependence principle). *GRE claims about AI capability, substitution, complementarity, dependence, or asymmetry should preserve system, task, access, and deployment conditions whenever changes in those conditions can materially alter the result.*

AI evidence can also be endogenous to the systems being studied. Synthetic content can enter training corpora, benchmarks can influence development priorities, and widespread model use can change human behavior or institutional workflows that later evaluations treat as background. These feedbacks make provenance and temporal sequencing especially important.

Proposition 25.301 (AI sociotechnical attribution principle). *When an observed AI-era economic outcome depends materially on complementary human labor, organizational design, data access, infrastructure, institutional authority, or feedback from prior deployment, GRE should attribute the outcome to the relevant sociotechnical configuration rather than to model capability alone.*

25.12.8 Other Domains

The preceding domains are important interfaces, but they do not constitute an exhaustive list of admissible evidence. Demography, sociology, anthropology, psychology, political science, geography, public health, science and technology studies, organization studies, linguistics, media studies, design research, engineering, and other fields may become relevant when their objects bear materially on a GRE claim. Fixing a closed list would conflict with the programme's historical and disciplinary revisability because future economic problems can create interfaces that are presently unanticipated.

Definition 25.302 (Open-domain admission protocol). *An open-domain admission*

protocol is a procedure for incorporating evidence from a source domain not already stabilized within GRE by documenting the source object's warrant, the target GRE object, the relevance relation, necessary translation, non-translated remainder, scope conditions, and possible programme consequences before broader generalization is attempted.

The protocol makes relevance problem-specific. Public-health evidence may matter for labor capacity, care relations, inequality, or institutional resilience. Demographic evidence may matter for household structure, intergenerational transfer, migration, or fiscal systems. Anthropological evidence may matter for value categories, exchange practices, kinship, or institutional meaning. Engineering evidence may matter for infrastructure feasibility and material constraints. None of these examples licenses unrestricted transfer from the source discipline to GRE.

Definition 25.303 (Domain relevance claim). A *domain relevance claim* states why a source-domain evidential object bears materially on a specified GRE object and identifies the inferential steps required for that bearing to hold.

Relevance claims should remain contestable. A source domain can provide strong evidence about one component of an economic process while remaining silent about another. Expertise should therefore be distributed by object and warrant rather than ranked globally. The appropriate question is which domain can responsibly constrain which part of the GRE account under the conditions at issue.

Definition 25.304 (Programme domain-evidence register). A *programme domain-evidence register* is a versioned record of domain evidence packets, their target GRE objects, translation decisions, source-domain validity conditions, unresolved remainders, correction outcomes, and later re-epistemization events.

The register creates continuity across cases. It can reveal that a GRE concept repeatedly fails when confronted with one domain, that a relation appears across several domains under different names, or that an apparent cross-domain regularity disappears once source predicates are restored. Such patterns can motivate the next stage of inquiry, but they do not themselves establish a general theory.

Proposition 25.305 (Domain relevance non-exhaustion principle). *The set of domains relevant to GRE should remain open because relevance is generated by the research object and available evidence rather than fixed by a permanent disciplinary inventory.*

Proposition 25.306 (Domain evidence before generalization). *Cross-domain generalization within GRE should be preceded by domain-specific evidence interfaces that preserve source validity conditions, translation losses, and counterexamples sufficiently well to distinguish a recurring structure from an artifact of vocabulary or abstraction.*

Proposition 25.306 marks the boundary of the present section. Openness to domain evidence establishes how external and neighboring knowledge can enter GRE as correction, constraint, extension, or defeat. It does not yet establish that similar findings across domains instantiate one common structure. The following section therefore turns to cross-domain learning under a stricter question: how shared questions, structures, translations, and candidate generalizations can be investigated while domain-specific vocabulary, failed translation, and deferred unification remain visible.

25.13 Cross-Domain Learning with Scoped Generalization

Section 25.12 established an ingress architecture through which evidence from economics and neighboring domains can correct GRE while retaining the source-domain predicates on which that evidence depends. The present section addresses the next programme-level problem: how inquiry can learn across domains after those differences have been preserved. Its role is to distinguish several forms of cross-domain learning from stronger claims of theoretical unification. Its objective is to identify the conditions under which shared questions, recurrent structures, counterexamples, vocabulary, translations, and non-translations can alter inquiry without being redescribed prematurely as evidence for one general theory. The discussion proceeds comparatively and provenance-sensitively. Domain-specific warrants remain attached to the objects being compared, and generalization is treated as one possible outcome among several rather than as the default endpoint of comparison.

Cross-domain learning can occur even when domains remain theoretically distinct. A legal account can reveal that an economic category depends on enforceable status. Ecological evidence can expose a material boundary omitted by an economic representation. Historical inquiry can show that an apparently stable institution is temporally specific. Educational research can reveal a conversion process between resources and capabilities that economic measurement only partially observes. These contributions can change GRE without implying that law, ecology, history, education, and economics instantiate one fully specified theoretical structure.

Definition 25.307 (Cross-domain learning episode). *A cross-domain learning episode is a documented change in a question, distinction, interpretation, hypothesis, model, scope condition, or research priority that results from comparison among domain-specific objects while preserving the warrants and limitations that make those objects meaningful within their source domains.*

This definition makes learning broader than successful translation. A failed translation can expose a hidden assumption. A counterexample can narrow a candidate structure. A shared question can create collaboration without shared answers. A vocabulary difference can reveal that two apparently similar terms organize distinct objects. Cross-domain learning therefore concerns changes in understanding produced by disciplined comparison, including changes that reduce the plausible scope of a generalization.

Definition 25.308 (Cross-domain comparison unit). *A cross-domain comparison unit is a domain-identified object prepared for comparison by recording its local meaning, evidential or interpretive warrant, relevant relations, historical and institutional conditions, intended comparison dimension, and known limits of portability.*

Comparison units can be concepts, mechanisms, events, institutional forms, evidential patterns, normative distinctions, models, or research questions. Their preparation prevents a recurring error: comparing words detached from the objects and warrants that gave them analytical content.

Table 25.13 summarizes the principal learning states developed in this section.

Proposition 25.309 (Cross-domain learning condition). *Cross-domain comparison constitutes programme learning when it produces a reconstructable change in inquiry while preserving enough source-domain information to identify what was compared,*

Table 25.13: Cross-domain learning states and safeguards against premature unification

Learning state	Programme contribution	Primary safeguard
Shared question	Coordinates inquiry around a related problem without presuming common answers	Preserve domain-specific predicates and correction authorities
Shared structure	Identifies a candidate correspondence among relations, roles, or transformations	Distinguish independently reconstructed recurrence from shared vocabulary
Domain counterexample	Exposes a hidden scope condition, assumption, mechanism difference, or translation failure	Match the counterexample to the claimed scope before revising it
Domain-specific vocabulary	Retains distinctions that carry local constitutive, evidential, historical, or normative content	Compare meanings and uses before treating terminology as equivalent
Translation	Makes a partial mapping explicit for a stated analytical purpose	Record preserved content, transformation, and translation remainder
Non-translation	Preserves a material difference when a responsible mapping is unavailable or misleading	State the reason, consequences, and reopening conditions
Candidate generalization	Proposes a broader, testable correspondence supported by several domain-specific inquiries	Control for shared origin, adverse cases, and loss of analytical content
Deferred generalization	Keeps a broader claim open while current evidence remains insufficient or unstable	Record what is missing and what future evidence could alter the status

what was learned, what remains domain-specific, and which stronger conclusions remain unwarranted.

The condition allows GRE to benefit from comparison without assigning every useful correspondence the same theoretical status. The following subsections develop the eight learning states separately.

25.13.1 Shared Questions

Cross-domain inquiry often begins with a relation among questions rather than a relation among answers. Different disciplines can investigate dependence, recognition, allocation, constraint, participation, institutional persistence, capability formation, historical change, or value conflict because these phenomena intersect their respective problem-spaces. The questions remain differently typed. Economics may ask how an institution changes incentives or distributions; law may ask how the same institution constitutes rights and duties; governance research may ask how it is implemented; history may ask how it emerged; and political theory may ask how its authority can be justified.

Definition 25.310 (Shared question family). A *shared question family* is a set of

domain-specific research questions whose objects or consequences materially intersect while their predicates, evidential burdens, explanatory aims, or normative authorities remain partly distinct.

A shared question family coordinates attention without homogenizing the inquiries. The intersecting object can be a policy, institution, technology, population, resource system, or historical process. What makes the questions related is that answers in one domain can alter assumptions, boundary conditions, or consequences relevant to another.

Definition 25.311 (Question correspondence record). *A question correspondence record identifies the participating domains, each domain's question in its own vocabulary, the common empirical or relational object where one exists, the dependency relations among the questions, possible answer pathways, and the points at which domain-specific inquiry should remain separate.*

The record helps distinguish genuine question sharing from a broad theme. A study of an AI-supported educational system, for example, can generate economic questions about cost and labor; educational questions about learning and capability formation; legal questions about data or responsibility; governance questions about institutional oversight; and AI-studies questions about system behavior. The presence of one empirical object does not make these questions interchangeable.

Proposition 25.312 (Question-sharing non-equivalence principle). *The fact that several domains investigate the same empirical setting or relational process supports coordination among their questions but does not by itself establish equivalence among their explanatory predicates, methods, or standards of adequate answer.*

Proposition 25.313 (Question-portability condition). *A question can be transported across domains responsibly when the target inquiry restates the question in target-domain terms, identifies which source assumptions remain relevant, and records which predicates require independent reconstruction rather than lexical substitution.*

Shared questions therefore create a low-commitment form of cross-domain learning. They can identify missing expertise, expose dependencies among research tasks, and organize collaborative agendas before any shared structure has been established.

25.13.2 Shared Structures

A stronger form of learning arises when independently examined domains exhibit related structures. The relevant correspondence can concern roles, relations, transformations, constraints, sequences, feedbacks, conversion processes, or patterns of persistence. Structural comparison requires more than recurrence of words such as relation, power, value, institution, or generation. Those terms may have entered several domains through common theoretical ancestry or may denote materially different objects.

Definition 25.314 (Candidate shared structure). *A candidate shared structure is a proposed correspondence among domain-specific relations, roles, transformations, or constraints that remains identifiable after each participating domain has reconstructed the relevant object according to its own evidence, concepts, and correction conditions.*

The definition assigns priority to domain reconstruction. A recurring structure becomes more informative when it survives the possibility that a receiving domain

could modify or reject the vocabulary in which the comparison was first proposed.

Definition 25.315 (Structural correspondence profile). A *structural correspondence profile* records the participating domain objects, proposed corresponding elements, relational or transformational roles, conditions under which the correspondence holds, domain-specific differences, alternative mappings, and the residual content that the proposed correspondence does not preserve.

A profile can reveal partial correspondence. Two domains may share a dependence relation while differing in how the dependent position is constituted. They may share a conversion architecture while differing in the objects being converted and the authority governing the conversion. Partiality is analytically valuable because it indicates which features might support broader comparison and which should remain local.

Proposition 25.316 (Independent-reconstruction priority). *Evidence for a shared structure is strengthened when the relevant correspondence survives domain-specific reconstruction that could have produced divergence, and it is weakened when the apparent correspondence is largely inherited from common terminology or modeling assumptions.*

Proposition 25.317 (Structural similarity non-equivalence). *A structural correspondence across domains supports comparison at the level actually preserved by the mapping; it does not automatically establish equivalence of mechanisms, meanings, normative status, causal roles, or ontological interpretation.*

This principle keeps structural learning modular. A recurring relational form can remain useful even when its mechanisms differ, provided the comparison states precisely which structural features are being preserved.

25.13.3 Domain Counterexamples

Cross-domain learning becomes more reliable when comparison includes cases capable of resisting the proposed correspondence. Domains can supply counterexamples because their objects, histories, methods, scales, or normative structures strain assumptions that appear unproblematic within the source domain. A candidate derived from market institutions may fail under kinship-based exchange; a concept developed for human subjects may require modification for collective or artificial systems; a smooth quantitative model may fail where legal status changes discontinuously; and a short-run economic mechanism may become misleading under ecological irreversibility.

Definition 25.318 (Cross-domain learning counterexample). A *cross-domain learning counterexample* is a domain-specific case that falls within the stated comparison scope of a proposed cross-domain correspondence yet fails a required semantic, structural, mechanistic, evidential, historical, formal, or normative condition of that correspondence.

Counterexamples should be matched to claims. A case outside the declared scope may reveal a boundary worth studying without refuting the claim. A case within the declared scope has stronger revisionary force because it shows that the proposed correspondence omitted a condition or combined unlike objects.

Definition 25.319 (Counterexample propagation record). A *counterexample propagation record* documents the failed condition, the domain in which failure occurred,

the candidate claims and translations affected by the failure, alternative diagnoses, revisions made in response, and the programme objects that remain unaffected.

The propagation record prevents a local failure from being either ignored or over-generalized. A counterexample to one translation can leave the source-domain claim intact. A failure of one candidate generalization need not defeat a broader relational research programme. Conversely, a failure that reveals a foundational hidden assumption can legitimately propagate across several dependent claims.

Proposition 25.320 (Counterexample asymmetry principle). *A cross-domain counterexample can justify narrowing, decomposing, or rejecting a candidate correspondence more directly than a single successful comparison can justify broadening it, because positive transfer requires additional evidence that the preserved relation survives other domain differences.*

Proposition 25.321 (Adversarial-domain selection principle). *Cross-domain learning is more informative when comparison includes domains or cases selected for material differences likely to expose hidden assumptions, rather than relying only on domains already organized through similar concepts or institutions.*

Adversarial comparison makes difference productive. It allows a research programme to learn where its concepts stop traveling and why.

25.13.4 Domain-Specific Vocabulary

Vocabulary carries analytical history. Terms such as value, right, recognition, capability, efficiency, resilience, learning, agency, person, institution, or power can have specialized meanings that depend on disciplinary debates, measurement practices, legal authority, historical usage, or normative commitments. Cross-domain inquiry loses information when these terms are treated as interchangeable merely because their ordinary-language meanings overlap.

Definition 25.322 (Domain semantic profile). *A domain semantic profile records how a term or concept is used within a specified domain, including its referent, constitutive relations, inferential role, measurement or evidential access where relevant, historical or institutional context, normative loading, and contrasts with nearby concepts.*

Semantic profiles make apparent agreement testable. If two domains use the word *capability*, for example, the comparison should identify whether each refers to technical performance, human opportunity, organizational capacity, legal competence, or another object. A common label can conceal different predicates; different labels can also describe related structures.

Definition 25.323 (Cross-domain semantic collision). *A cross-domain semantic collision occurs when the same or closely related term is used across domains for objects whose materially relevant meanings, warrants, or implications differ enough that unqualified substitution produces a misleading correspondence.*

The inverse problem also matters. Domain-specific terms can appear incommensurable while serving related structural roles. Careful comparison should therefore avoid both terminological assimilation and terminological isolation.

Proposition 25.324 (Vocabulary-retention principle). *Cross-domain comparison should retain domain-specific vocabulary whenever the vocabulary carries constitutive, evidential, historical, formal, or normative distinctions that would be weakened*

by immediate replacement with a more general term.

Proposition 25.325 (Terminological recurrence non-evidence). *Recurrence of the same vocabulary across domains does not by itself constitute evidence for a shared structure, especially when the vocabulary was inherited from a common framework or circulated through interdisciplinary borrowing.*

Domain-specific vocabulary thereby functions as a diagnostic resource. It can reveal where translation requires work and where a proposed general language has become too coarse to preserve the objects being studied.

25.13.5 Translation

Translation creates an explicit relation between domain-specific objects. Its purpose can be comparative explanation, hypothesis generation, data coordination, model transfer, institutional analysis, or interdisciplinary communication. The appropriate translation depends on that purpose. A mapping sufficient for identifying a shared research question may be too weak for transferring a causal mechanism or normative criterion.

Definition 25.326 (Typed cross-domain translation). *A typed cross-domain translation is a purpose-specific, partial mapping from a source-domain object and its relevant predicates or relations to a target-domain object, together with a record of preserved content, transformed content, omitted content, uncertainty, and translation remainder.*

The translation is typed because concepts, mechanisms, evidential relations, institutional roles, formal structures, and normative criteria require different forms of correspondence. A semantic translation does not automatically transfer causal warrant; a structural translation does not automatically transfer normative authority.

Definition 25.327 (Translation purpose profile). *A translation purpose profile states the analytical task for which a cross-domain mapping is constructed, the minimum content that must be preserved for that task, the losses that remain acceptable, and the inferences that the mapping does not authorize.*

Purpose profiles constrain overreach. They allow a translation to be useful without pretending to be complete. A legal category may be translated into an economic constraint for one model while its doctrinal meaning and normative authority remain outside that model. An ecological threshold may enter an economic feasibility analysis while its ecological significance remains richer than the economic representation.

Definition 25.328 (Reciprocal translation check). *A reciprocal translation check examines whether domain experts or domain-grounded reconstructions can recover the materially relevant source distinction after translation, and records distortions that appear when the translated object is interpreted from the receiving domain.*

Reciprocity need not imply symmetry. Some translations are legitimately one-directional because one domain supplies a constraint or constitutive fact to another. The check asks whether the translation preserves enough information for its declared purpose and whether receiving-domain interpretation has silently changed the source object.

Proposition 25.329 (Translation adequacy condition). *A cross-domain translation is adequate for a stated purpose when its preserved content is sufficient for the intended inference, its transformation and remainder are explicit, source-domain warrant is not*

falsely transferred, and relevant target-domain reconstruction does not reveal a material distortion that defeats the intended use.

Translation under this condition becomes a revisable research result. Later evidence can refine the mapping, split one translation into several typed translations, or replace it with non-translation.

25.13.6 Non-Translation

Some cross-domain relations are more accurately represented by an explicit absence of translation. Non-translation can arise because the source concept depends on constitutive authority absent in the target domain, because the relevant evidence has no defensible counterpart, because normative predicates cannot be transported without independent argument, because historical meanings diverge, or because the available comparison is too coarse to preserve the distinction at issue.

Definition 25.330 (Programme non-translation state). *A programme non-translation state is an explicit, revisable determination that a source-domain object should remain untranslated for a specified cross-domain purpose because the available mapping would erase or misstate materially relevant content.*

A non-translation state is therefore a positive research record. It identifies where comparison currently reaches its limit and prevents later users from treating absence of a common term as absence of an analytical problem.

Definition 25.331 (Non-translation rationale). *A non-translation rationale records the source and target domains, focal object, attempted or considered mappings, the material content that would be lost or distorted, comparisons that remain permissible, and evidence or conceptual development that could justify reopening translation later.*

Non-translation can coexist with coordination. Researchers can share questions, exchange evidence, or compare consequences while leaving a constitutive concept untranslated. Legal validity, aesthetic judgment, ecological integrity, lived cultural meaning, or educational formation may intersect an economic problem without becoming economic variables of equivalent meaning.

Proposition 25.332 (Informative non-translation principle). *A well-specified non-translation can increase cross-domain knowledge by locating a boundary of correspondence, identifying the content responsible for that boundary, and preventing a misleading generalization from entering the programme.*

Proposition 25.333 (Non-translation revisability principle). *A programme non-translation state should remain reopenable when new concepts, evidence, methods, or domain reconstructions provide a mapping that preserves the content previously lost or distorted.*

This combination of preservation and revisability keeps non-translation from becoming disciplinary isolation. The boundary is documented because the present mapping is inadequate, not because cross-domain inquiry is forbidden.

25.13.7 Candidate Generalization

A candidate generalization becomes appropriate when several domain-specific inquiries support a correspondence that remains analytically informative after trans-

lation losses, vocabulary differences, and adverse cases are considered. The status remains provisional. The candidate proposes a broader scope for testing; it does not convert recurrence into universality.

Definition 25.334 (Cross-domain candidate generalization). A *cross-domain candidate generalization* is a scoped, contestable hypothesis that a specified relation, structure, transformation, constraint, or generative pattern recurs across more than one domain under stated conditions and retains analytical content after domain-specific reconstruction.

Candidate status requires identifiable content. A formulation so abstract that every domain can satisfy it by reinterpretation supplies little basis for testing. Conversely, a candidate can remain narrow: a particular kind of conversion relation or dependence structure may generalize farther than the substantive objects connected by that relation.

Definition 25.335 (Candidate-generalization record). A *candidate-generalization record* contains the proposed generalized content, participating domain comparison units, evidence of independent reconstruction, translations and non-translations, counterexamples sought and found, shared-origin dependencies, current scope conditions, remaining domain-specific content, and explicit revision or rejection triggers.

The record separates programme memory from rhetorical breadth. A candidate can accumulate support, be narrowed, branch into typed variants, return to a domain-specific status, or be abandoned while its history remains reconstructable.

Proposition 25.336 (Independence-sensitive support principle). *Support for a cross-domain candidate generalization should increase with independently warranted recurrence across materially different domains and should be discounted when recurrence is substantially explained by shared vocabulary, common theoretical ancestry, coordinated modeling choices, or closely related institutional settings.*

Proposition 25.337 (Generalization content-preservation principle). *A broader cross-domain formulation remains analytically useful only if abstraction preserves enough content to distinguish supporting cases from relevant counterexamples and to generate consequences that can be contested in participating domains.*

Proposition 25.338 (Candidate-generalization admission condition). *GRE can admit a cross-domain generalization as a programme-level candidate when the proposed recurrence is reconstructed through domain-specific evidence, semantic differences and translation remainders are explicit, relevant counterexamples have been sought, shared-origin dependence is recorded, and the resulting claim remains narrower than the evidence needed for a completed general theory.*

The condition permits ambitious comparison while preserving the book's ontological and disciplinary restraint. A candidate can guide future GR or GRT research without being presented as an established cross-domain law.

25.13.8 Deferred Generalization

Cross-domain inquiry does not require a decision between immediate unification and permanent separation. Many comparisons will remain evidentially immature, semantically unstable, historically narrow, or dependent on domains that have not yet developed sufficiently independent formulations. In such cases, deferral can pre-

serve a promising question without overstating what current comparison establishes.

Definition 25.339 (Deferred generalization). A *deferred generalization* is a documented programme state in which a broader cross-domain claim remains open for future inquiry while current evidence, translation quality, domain independence, counterexample coverage, or conceptual stability is judged insufficient for candidate-generalization status.

Deferral differs from rejection. A rejected generalization has encountered evidence or argument sufficient to withdraw the proposed claim in its current form. A deferred generalization lacks sufficient warrant to promote the claim and may also lack sufficient evidence to defeat it. The distinction preserves uncertainty as an explicit research state.

Definition 25.340 (Generalization deferral record). A *generalization deferral record* identifies the proposed cross-domain relation, current supporting observations, unresolved semantic or evidential differences, missing domains or adverse cases, translation problems, shared-origin concerns, and concrete conditions under which the claim could be promoted, revised, decomposed, or rejected.

Deferral can protect domain learning from theoretical pressure. Researchers remain free to develop independent concepts and methods rather than fitting early work to a general architecture announced before adequate comparison exists. The resulting diversity can later provide stronger evidence because agreement, when it occurs, has survived genuine opportunities for divergence.

Proposition 25.341 (Deferral without theoretical loss). *Deferring cross-domain generalization need not reduce programme knowledge when the comparison has already produced shared questions, domain-specific corrections, structural correspondences, counterexamples, translations, or non-translations that remain useful independently of a unifying claim.*

Definition 25.342 (Cross-domain learning portfolio). A *cross-domain learning portfolio* is a versioned programme record linking shared question families, structural correspondence profiles, counterexample propagation records, domain semantic profiles, translations, non-translations, candidate-generalization records, deferred generalizations, and later revisions across participating domains.

The portfolio prevents cross-domain inquiry from being remembered only through its successful generalizations. Failed mappings, domain-specific remainders, rejected candidates, and deferred questions remain part of the programme's evidence about where broader claims do and do not travel.

Proposition 25.343 (Learning-before-unification principle). *GRE can sustain productive cross-domain learning without premature unification when comparison is allowed to terminate provisionally in several legitimate states, including shared questions, partial structural correspondence, counterexample, translation, non-translation, candidate generalization, and deferral, with each state retaining explicit conditions for later revision.*

The principle gives cross-domain inquiry an open temporal structure. Some correspondences may accumulate enough independently warranted support to become stronger candidates for a future general theory. Others may branch into typed families, remain domain-specific, or disappear after counterevidence. The next section therefore turns from the status of cross-domain learning to the more general dynamics through which a research programme changes over time: accumulation, critique,

revision, branching, hybridization, abandonment, re-emergence, and programme transformation.

25.14 Theoretical Evolution

Section 25.13 established that cross-domain learning can end provisionally in several states, including translation, non-translation, candidate generalization, and deferral. The present section addresses the temporal problem that follows from such plurality: how a research programme changes when evidence, criticism, alternative formulations, imported concepts, failed models, and reopened questions accumulate across successive versions. Its role is to characterize theoretical evolution without assuming that later formulations are automatically more adequate, more unified, or closer to a final theory. Its objective is to distinguish several modes of programme change and to specify the lineage information needed to reconstruct continuity, divergence, retirement, and transformation. The discussion is version-sensitive and dependency-sensitive. Changes are evaluated according to what they alter, what they preserve, which dependent objects they affect, and whether programme identity remains continuous.

The term *evolution* is used descriptively. It does not import a biological mechanism, a criterion of fitness, or a presumption of progress. A theoretical lineage can become more empirically adequate in one respect while losing explanatory economy in another. It can gain domain reach while accumulating translation problems. It can branch into incompatible descendants, abandon once-central concepts, recover earlier ideas under new conditions, or change enough that successor-programme language becomes more accurate than continuity language. The relevant object is therefore a reconstructable history of theoretical change rather than an assumed trajectory of improvement.

Definition 25.344 (Theoretical programme state). A *theoretical programme state* is a versioned configuration of programme commitments, concepts, distinctions, hypotheses, formal representations, methods, domain interfaces, evidential warrants, normative assumptions, unresolved alternatives, and dependency relations that is identifiable at a specified stage of inquiry.

Definition 25.345 (Theoretical change event). A *theoretical change event* is a documented alteration between programme states that identifies the objects added, challenged, revised, branched, hybridized, abandoned, reactivated, or transformed, together with the reasons, affected dependencies, and resulting epistemic status changes.

These definitions make programme history granular enough to distinguish change in content from change in status. A concept can remain textually unchanged while its warrant weakens. A formalism can survive while its interpretation changes. A domain application can be abandoned without altering core programme commitments. Conversely, a brief revision to a foundational distinction can propagate through many downstream claims.

Table 25.14 summarizes the principal modes of theoretical evolution developed in this section.

Proposition 25.346 (Non-teleological evolution principle). A *later GRE programme state should not be treated as epistemically superior merely because it is later; improve-*

Table 25.14: Modes of theoretical evolution and their principal lineage requirements

Mode	Characteristic programme change	Principal lineage requirement
Accumulation	Adds evidence, distinctions, methods, domains, or derived results while preserving earlier objects provisionally	Record compatibility, redundancy, and integration effects
Critique	Challenges assumptions, warrants, scope, interpretation, or consequences	Preserve target, objection, response, and unresolved remainder
Revision	Alters an existing programme object or its status	Track retained, replaced, added, withdrawn, and dependent objects
Branching	Produces divergent descendants from a shared programme state	Preserve common ancestry, branch conditions, and later compatibility
Hybridization	Combines resources with an external or distinct theoretical lineage	Preserve provenance, translation interfaces, and incompatibilities
Abandonment	Retires an object or line of inquiry from active programme use	Preserve reasons, dependency effects, and residual historical value
Re-emergence	Reactivates an inactive or abandoned object under changed conditions	Re-evaluate original assumptions rather than restoring the object unchanged
Programme transformation	Changes the architecture or commitments sufficiently to alter programme identity	Record continuity, discontinuity, and possible successor relations

ment, deterioration, diversification, simplification, loss, and unresolved tradeoff are all possible outcomes of theoretical change.

The proposition provides the common discipline for the eight modes that follow.

25.14.1 Accumulation

The simplest appearance of theoretical growth is addition. A programme can acquire new evidence, distinctions, datasets, domain studies, formal tools, historical cases, methodological procedures, or derived propositions without immediately changing the status of its existing objects. Yet accumulation is theoretically meaningful only when the relation between new and inherited material is known. Mere volume can obscure contradiction, redundancy, and incompatible assumptions.

Definition 25.347 (Programme accumulation). *Programme accumulation* is the addition of a research object to an existing theoretical programme state while the previously registered objects remain provisionally active unless the addition supplies a reason to reconsider them.

Accumulation can be evidential, conceptual, methodological, formal, historical, normative, or domain-specific. These types need not have the same consequences. New evidence can strengthen or weaken a claim; a new concept can differentiate objects previously grouped together; a new method can expose a measurement limitation; and a new domain can reveal a hidden scope condition. Addition therefore

initiates a compatibility question even when no explicit contradiction is apparent.

Definition 25.348 (Accumulation integration record). An *accumulation integration record* identifies the added object, its provenance and epistemic status, the programme objects to which it is related, compatibility or tension with inherited assumptions, redundancies, new dependencies, and any questions reopened by the addition.

The record prevents accumulation from becoming an append-only archive. If several studies repeatedly add evidence that depends on the same unexamined measurement convention, their numerical multiplicity should not be confused with independent support. If a new distinction divides an inherited category, earlier conclusions may require reclassification even when they remain locally valid.

Proposition 25.349 (Integrated accumulation condition). *An addition constitutes theoretically integrated accumulation when its relation to existing programme objects is explicit enough to determine whether it supplies independent support, refinement, redundancy, tension, or a reason for later revision.*

Proposition 25.350 (Accumulation non-monotonicity). *The accumulation of programme objects need not produce monotonic growth in confidence or scope, because additional evidence, concepts, and domains can reveal dependencies, conflicts, or limitations that narrow earlier claims.*

Accumulation is therefore a temporal input to theoretical evolution rather than a metric of progress. Its value depends on how the added material changes the programme's reconstructable structure.

25.14.2 Critique

Critique makes theoretical change answerable to reasons that challenge an existing programme state. The relevant challenge can concern empirical support, conceptual coherence, formal assumptions, historical interpretation, normative adequacy, domain transfer, institutional consequences, or omitted alternatives. Critique can originate inside GRE or from another discipline, affected community, empirical setting, or competing theoretical tradition.

Definition 25.351 (Programme critique event). A *programme critique event* is a documented challenge to a specified programme object that states the contested claim, assumption, method, interpretation, scope, or consequence; the basis of the challenge; and the programme response required to evaluate it.

Critique becomes more informative when its target is precise. A criticism of one empirical operationalization should not automatically be treated as a criticism of relational analysis as such. A challenge to one normative criterion may leave descriptive claims unaffected. Conversely, a critique that exposes a foundational assumption can propagate beyond the object where it first appeared.

Definition 25.352 (Critique target map). A *critique target map* identifies the directly challenged programme object, its supporting assumptions and warrants, dependent objects, parallel formulations, plausible repair paths, and portions of the programme that the critique does not presently reach.

The target map gives criticism a dependency structure. It also protects the programme from two symmetrical responses: insulating a central claim by redescribing every objection as local, and treating every local objection as defeat of the entire pro-

gramme.

Definition 25.353 (Critique uptake state). A *critique uptake state* records whether a challenge is presently unanswered, under investigation, provisionally answered, partially sustained, sustained, displaced by reformulation, or judged outside the declared scope, together with the reasons for that status.

Proposition 25.354 (Critique traceability principle). *Programme criticism contributes to theoretical evolution when the challenge, target, response, remaining disagreement, and downstream consequences remain traceable even when the programme ultimately rejects the criticism.*

Proposition 25.355 (Critique without forced convergence). *A research programme can learn from critique without requiring agreement among the participating positions, provided the disagreement clarifies assumptions, evidential burdens, scope conditions, or alternative explanations in a form that later inquiry can revisit.*

Critique thereby changes the programme even when it does not produce immediate revision. It can make previously tacit assumptions explicit, identify tests that had not been considered, or preserve a live alternative against which later formulations remain answerable.

25.14.3 Revision

Revision alters an inherited programme object in response to evidence, critique, internal inconsistency, conceptual refinement, domain learning, methodological change, or normative reconsideration. Theoretical revisability becomes substantive only when a revision can be reconstructed. A rewritten claim without a record of what changed obscures both learning and responsibility.

Definition 25.356 (Programme revision event). A *programme revision event* is a versioned modification of a programme object that records the prior formulation, revised formulation, reason for revision, retained content, altered or withdrawn content, changed epistemic status, and consequences for dependent objects.

Revision can be local, intermediate, or architectural. A local revision may alter a parameterization or domain boundary. An intermediate revision may change a concept that organizes several sections or models. An architectural revision may change a foundational distinction, core commitment, or dependency pattern across the programme. These categories describe propagation potential rather than prestige.

Definition 25.357 (Revision radius). The *revision radius* is the documented range of programme objects whose interpretation, warrant, scope, or active status requires reconsideration because of a specified revision.

A revision radius can be smaller or larger than the textual extent of the edit. Replacing one sentence can have a large radius if many later claims depend on it. Rewriting several pages can have a small radius if the changes improve exposition without altering substantive commitments.

Definition 25.358 (Revision propagation record). A *revision propagation record* identifies the revised object, direct dependencies, indirect dependencies, unaffected objects, required revalidation tasks, unresolved consequences, and later programme states in which the revision has been incorporated.

Proposition 25.359 (Dependency-sensitive revision principle). *The adequacy of a theoretical revision depends partly on whether materially affected downstream objects are*

re-evaluated rather than silently carried forward under assumptions that the revision has altered.

Proposition 25.360 (Revision continuity condition). *A revised formulation remains reconstructably continuous with its predecessor when the lineage record makes clear which problem is being retained, which content is preserved, why the alteration occurred, and which earlier conclusions remain valid under the new formulation.*

Revision thus combines change with memory. It does not require maximal conservation, but it requires enough continuity information to distinguish a developed claim from an unrelated replacement presented under the same name.

25.14.4 Branching

Revision need not converge on one successor formulation. Evidence can remain underdetermining, values can differ, formal choices can emphasize different structures, and domain applications can require incompatible simplifications. Under these conditions, a common programme state can generate several descendants. Branching makes such divergence explicit rather than forcing premature synthesis.

Definition 25.361 (Theoretical branch). *A theoretical branch* is a descendant formulation that preserves a reconstructable relation to a shared programme ancestor while developing a materially distinct set of claims, assumptions, methods, interpretations, or domain commitments.

A branch can remain internal to GRE when its divergence occurs within the programme's current identity conditions. Greater divergence can create a successor candidate whose relation to GRE is genealogical rather than simply internal. The classification should follow the content of the divergence rather than the preference of its proponents.

Definition 25.362 (Branch point record). *A branch point record* identifies the common ancestor, question or tension generating divergence, alternative commitments adopted by each descendant, evidence available at the time, shared content retained after divergence, and conditions under which comparison or recombination remains meaningful.

Definition 25.363 (Branch compatibility profile). *A branch compatibility profile* records which concepts, evidence, methods, formal objects, normative premises, and conclusions can be transferred or compared across branches, which require translation, and which remain incompatible under their current formulations.

Branches can serve different domains or questions without standing in direct competition. Other branches can make incompatible claims about the same object. A programme should therefore avoid treating plurality itself as evidence of complementarity.

Proposition 25.364 (Branch legitimacy condition). *Branching is a legitimate mode of programme evolution when divergence is explicit, common ancestry remains reconstructable, branch-specific assumptions are identifiable, and the branches remain open to comparison, criticism, and possible defeat.*

Proposition 25.365 (Branch plurality non-complementarity). *The coexistence of several programme branches does not establish that their claims are mutually compatible or jointly exhaustive; compatibility and complementarity require separate analysis at the level of the objects in dispute.*

Branching therefore turns underdetermination and disagreement into an organized research state. It can preserve alternatives long enough for later evidence or conceptual development to discriminate among them.

25.14.5 Hybridization

Theoretical programmes also change through contact with external or partly independent lineages. GRE can incorporate a concept, method, formal device, historical interpretation, empirical instrument, or normative distinction developed elsewhere. Such incorporation can be productive, but it creates a stronger provenance burden than ordinary accumulation because the imported object carries assumptions and meanings formed within another theoretical environment.

Definition 25.366 (Theoretical hybridization). *Theoretical hybridization* is a programme change in which objects from distinct theoretical or disciplinary lineages are combined into a new formulation whose operation depends materially on resources inherited from more than one lineage.

Hybridization differs from citation or loose inspiration. The external object becomes part of the programme's active analytical machinery. Its incorporation can change GRE, the imported object, or both.

Definition 25.367 (Hybridization interface). A *hybridization interface* records the imported object, source lineage, original role and assumptions, GRE target object, translation or modification performed during incorporation, preserved content, discarded content, new dependencies, and known incompatibilities.

Definition 25.368 (Hybrid compatibility audit). A *hybrid compatibility audit* examines whether the combined formulation relies on assumptions, ontological readings, evidential standards, scales, or normative commitments that conflict in ways material to the intended use.

Compatibility does not require complete theoretical agreement. A statistical method can be used within GRE without importing the source tradition's entire ontology. A legal distinction can constrain an economic model without becoming reducible to an economic variable. The audit instead asks which differences matter for the local construction.

Proposition 25.369 (Hybridization provenance principle). *A hybrid GRE formulation should preserve enough source-lineage information to distinguish inherited content, GRE-specific modification, and genuinely new consequences produced by their combination.*

Proposition 25.370 (Hybridization non-additivity). *The adequacy of a hybrid formulation cannot be inferred from the separate adequacy of its components, because their combination can create new incompatibilities, dependencies, interpretations, or empirical requirements.*

Hybridization thus expands the programme while keeping imported authority local. An external concept earns its role through the work it performs in the combined formulation, not through the prestige or breadth of its source theory.

25.14.6 Abandonment

An open research programme requires procedures for losing theoretical objects as well as gaining them. A claim may be defeated; a formalism may prove uninformative; a distinction may collapse under better evidence; a domain transfer may repeatedly fail; a research path may become ethically unacceptable; or an object may become redundant after a more adequate formulation is developed. Continued inclusion in such cases can create theoretical inertia.

Definition 25.371 (Programme abandonment). *Programme abandonment* is the explicit retirement of a claim, concept, formalization, method, translation, branch, or research path from active programme use under a stated rationale and with its historical record preserved.

Abandonment does not assign one epistemic meaning to every retired object. Some objects are rejected as false or incoherent. Others are superseded, rendered unnecessary, judged too costly for their informational yield, or suspended because their required evidence is unavailable. These reasons should remain distinguishable.

Definition 25.372 (Retirement dossier). A *retirement dossier* records the abandoned object, its prior programme role, reasons for retirement, evidence or argument supporting the decision, affected dependencies, replacement objects where any exist, residual uses, and conditions under which reconsideration would be appropriate.

Definition 25.373 (Residual theoretical value). *Residual theoretical value* is the remaining research significance of an inactive object as historical evidence, a documented failed path, a source of distinctions, a negative result, a comparison case, or a possible resource for later reanalysis.

Proposition 25.374 (Abandonment without erasure). *Retiring a programme object should remove its active authority without deleting the provenance needed to understand why it was once adopted, why it was later abandoned, and which conclusions depended on it.*

Proposition 25.375 (Inactive-status distinction). *Inactive programme objects should retain differentiated statuses such as defeated, superseded, redundant, deferred, ethically discontinued, or evidentially dormant when those distinctions affect the possibility and meaning of later reuse.*

The distinction is important because theoretical memory should not flatten every discontinued object into error. Some abandoned paths remain informative precisely because later conditions may change the basis on which they were judged.

25.14.7 Re-Emergence

Preserved theoretical objects can become relevant again when evidence, methods, technologies, historical circumstances, normative frameworks, or research questions change. Section 25.11 treated this possibility as re-epistemization. The present subsection concerns its programme-history consequence: a previously inactive object can re-enter active theoretical work while remaining marked by the history of its earlier use and retirement.

Definition 25.376 (Theoretical re-emergence). *Theoretical re-emergence* is the reactivation of an inactive, abandoned, or marginal programme object because changed epistemic or historical conditions make its questions, distinctions, methods, or representational resources newly relevant.

Re-emergence is therefore neither simple restoration nor vindication. A concept can return because a new domain gives it a productive role even if its original claim remains rejected. A model can become useful after computational conditions change while still requiring revised assumptions. An earlier normative concern can acquire new significance under an institutional configuration that did not exist when the concern was first formulated.

Definition 25.377 (Re-emergence review). A *re-emergence review* compares the object's earlier programme state with the conditions of proposed reactivation, including original assumptions, reasons for inactivity, changed evidence or methods, altered historical context, modifications required for current use, and unresolved reasons for caution.

Definition 25.378 (Reactivated-object status). A *reactivated-object status* records whether a re-emerging object is reused as a historical comparison, heuristic, revised concept, methodological resource, formal representation, empirical hypothesis, or active programme commitment.

The status prevents re-emergence from silently upgrading an object. Historical recovery can be valuable without restoring prior epistemic authority.

Proposition 25.379 (Re-emergence non-restoration principle). *The re-emergence of a theoretical object should be evaluated under current evidence and conditions rather than treated as restoration of its former status merely because the object has become relevant again.*

Proposition 25.380 (Historical-distance safeguard). *A re-emergence review should preserve the difference between the historical problem for which an object was originally formulated and the present problem for which it is being reconsidered, especially when institutions, technologies, categories, or normative conditions have changed.*

Re-emergence thereby links programme memory to theoretical novelty. Old objects can participate in new constructions, but their return becomes a new theoretical event with its own warrant.

25.14.8 Programme Transformation

Accumulation, critique, revision, branching, hybridization, abandonment, and re-emergence can occur while GRE remains recognizably the same research programme. Their cumulative effects can also alter the programme's architecture. A future formulation might change the role of relational analysis, redefine generativity, reorganize value plurality, replace major ontological or epistemological distinctions, shift the relation between economics and broader GR inquiry, or adopt methods and domain boundaries that make continuity increasingly genealogical rather than programmatic.

Definition 25.381 (Programme transformation). A *programme transformation* is a coordinated change across several programme components that materially alters the architecture, identity conditions, or characteristic problem-space through which the programme organizes inquiry.

Transformation is a matter of structure rather than the number of edits. Many revisions can leave the programme's identity kernel stable, while a small number of changes to foundational commitments can reorganize the whole dependency structure.

Definition 25.382 (Programme continuity profile). A *programme continuity profile* compares two programme states across their core commitments, characteristic questions, conceptual distinctions, methodological permissions, domain scope, dependency architecture, theoretical language, and recognized defeat or revision conditions.

The profile supports graded analysis without making identity purely subjective. Some dimensions can remain continuous while others change sharply. The relevant judgment is whether describing the later state as GRE still communicates a sufficiently stable programme identity for criticism, comparison, and historical reconstruction.

Definition 25.383 (Transformation threshold record). A *transformation threshold record* documents the changes judged material to programme identity, the continuity dimensions retained, competing interpretations of whether identity persists, and the reasons for describing the later formulation as an internal revision, a transformed GRE branch, or a successor programme.

Such records should allow disagreement. Programme identity is partly historical and interpretive, especially when a living research community changes over time. Explicit criteria are preferable to settling the issue through naming alone.

Proposition 25.384 (Programme succession condition). *Successor-programme language becomes appropriate when a later formulation preserves reconstructable descent from GRE while altering enough of the programme's core commitments, problem architecture, or correction conditions that ordinary internal-revision language would conceal material discontinuity.*

Definition 25.385 (Theoretical evolution portfolio). A *theoretical evolution portfolio* is a versioned programme record linking accumulation integration records, critique target maps, revision propagation records, branch point records, hybridization interfaces, retirement dossiers, re-emergence reviews, and transformation threshold records across successive programme states.

The portfolio gives theoretical history more structure than a sequence of publications. It preserves unsuccessful paths, unresolved disagreements, imported lineages, retired objects, and identity changes alongside currently active formulations. This record also makes retrospective re-epistemization less dependent on institutional memory or retrospective reconstruction from final texts alone.

Proposition 25.386 (Lineage-preserving evolution principle). *GRE remains an open and historically reconstructable research programme when theoretical change can add, challenge, revise, branch, hybridize, retire, reactivate, or transform programme objects while preserving enough lineage to identify what changed, why it changed, what consequences followed, and when continuity itself became contestable.*

The principle gives programme openness a temporal form. GRE need not survive by keeping every present concept, formalism, or conclusion intact. Its stronger continuity lies in preserving a recognizable problem-space, explicit correction conditions, and reconstructable relations among successive formulations while allowing evidence and argument to alter their content. The next section turns from the evolution of the research programme to the economic futures that such an open programme is prepared to study: futures characterized by contingency, plural values and subjects, participation, option preservation, and continued revisability rather than a predetermined economic endpoint.

25.15 Open Generative Economic Futures

Section 25.14 established that GRE can evolve without assuming that later theoretical states are automatically superior or that programme development converges toward one final formulation. The present section addresses the corresponding economic-order question. Its role is to clarify what follows, and what does not follow, when an open research programme studies economic futures that are themselves historically generated. Its objective is to characterize economic future openness without converting openness into a universal institutional blueprint, an injunction to maximize options, or a refusal of durable commitments. The discussion develops eight connected dimensions: endpoint openness, plural economic orders, historical contingency, heterogeneous values, heterogeneous subjects, generative participation, option preservation, and future revisability. The method is relational and future-formative. It evaluates economic arrangements through the possibilities, constraints, participation structures, value relations, inherited dependencies, and revision capacities they generate for later participants.

The argument extends the future-formation architecture developed earlier in Chapter 20. That earlier analysis distinguished prediction from future formation and treated represented, admissible, and practically reachable possibilities as different economic objects. The present section adds a programme-level conclusion: GRE does not derive one preferred terminal economic order from the fact that economic life is relational and generative. Relational analysis can reveal dependencies, exclusions, power concentrations, capability formation, value conflicts, and path-creation effects. Generative analysis can show how present arrangements alter later possibilities. Neither form of analysis, by itself, selects a final constitutional, ownership, market, planning, technological, or welfare architecture for every historical setting.

Definition 25.387 (Open generative economic future). An *open generative economic future* is a historically situated economic future in which consequential commitments coexist with sufficient plural standing, path-creation capacity, option preservation, institutional memory, contestability, and revision capability for later participants to continue forming, evaluating, and where materially possible altering the economic order they inherit.

The definition is intentionally conditional. Openness is not equivalent to permissiveness. Rights, safety constraints, ecological limits, fiduciary duties, anti-discrimination rules, public-health protections, technical standards, and other warranted forms of closure can be constitutive of an open future when they protect the conditions through which plural participants can continue to act and revise. Conversely, an arrangement can offer many nominal choices while concentrating the capability to generate consequential alternatives in a small number of actors.

Definition 25.388 (Economic-future openness profile). An *economic-future openness profile* records, for a specified economic configuration, the plurality of practically reachable orders and trajectories, historically contingent constraints, represented value structures, recognized subject positions, distributions of generative participation, preserved and foreclosed options, irreversible commitments, and institutional capacities for later review, repair, reinterpretation, and revision.

Table 25.15 summarizes the eight dimensions developed below.

Proposition 25.389 (Open-future non-prescription principle). *The GRE commitment to relational and generative analysis does not by itself warrant one universal economic*

Table 25.15: Dimensions of open generative economic futures and their principal safeguards

Dimension	Principal analytical object	Principal safeguard
Endpoint openness	Programme relation to possible economic endpoints	Separate diagnosis and evaluation from universal terminal prescription
Plural economic orders	Coexisting and competing institutional configurations	Compare configurations without presuming convergence or equivalence
Historical contingency	Path-dependent formation of feasible and intelligible arrangements	Reconstruct conditions that made alternatives reachable, latent, or foreclosed
Heterogeneous values	Several value structures with incomplete commensurability	Preserve value-specific losses, gains, conversion limits, and evaluative remainder
Heterogeneous subjects	Differentiated persons, collectives, artificial agents, and non-human positions	Avoid deriving common standing from one model of subjecthood
Generative participation	Capacity to influence later economic possibilities	Distinguish formal participation from consequential path-shaping capacity
Option preservation	Maintenance of meaningful later reachability	Preserve selected capabilities and pathways without maximizing option count
Future revisability	Capacity to reconsider inherited economic arrangements	Combine records, review, repair, successor capacity, and explicit irreversibility

endpoint; any preferred future order requires additional empirical, historical, institutional, and normative argument under stated scope conditions.

This principle gives the section its main restraint. GRE can evaluate how an order generates capacity, concentrates power, distributes risk, converts values, preserves or destroys options, or enables participation without claiming that those observations uniquely determine one final design.

25.15.1 Economic Endpoint Openness

An economic theory can become teleological when its analytical architecture is treated as evidence that history should, or will, culminate in one preferred institutional form. GRE should resist that move. Relationality does not imply one ownership regime. Generativity does not imply one planning mechanism. Value plurality does not imply one procedural settlement. Historical analysis does not imply that existing institutions are either necessary or disposable. The programme can identify conditions under which particular arrangements become more or less adequate without treating adequacy in one domain or period as a terminal conclusion for economic order as such.

Definition 25.390 (Economic endpoint). An *economic endpoint* is a proposed terminal or privileged configuration of institutions, ownership, allocation, production, exchange, governance, technological organization, welfare provision, or social reproduction that is treated as the expected or normatively preferred culmination of economic development.

Endpoints can be explicit, as in a declared ideal order, or implicit, as when evaluation consistently assumes that movement toward one institutional architecture is synonymous with progress. GRE can analyze endpoint proposals as historically situated normative and institutional objects. It should not infer their authority from the existence of a generative-relational framework.

Definition 25.391 (Endpoint-openness condition). The *endpoint-openness condition* is satisfied when a GRE analysis distinguishes its diagnostic and evaluative findings from any claim that one economic configuration constitutes the generally required terminal state, and when alternative arrangements remain assessable under explicit evidence, values, and scope conditions.

Endpoint openness does not prohibit strong recommendations. A specific jurisdiction can have compelling reasons to adopt universal health coverage, strengthen competition policy, prohibit a hazardous practice, build public infrastructure, or regulate a concentrated platform. The analytical discipline concerns the inference from local or domain-specific warrant to universal historical destination.

Proposition 25.392 (Local adequacy and terminal inference). *Evidence that one economic arrangement is preferable under specified conditions does not establish that the same arrangement is the final or generally optimal organization of economic life across other domains, periods, technologies, value structures, and subject configurations.*

Proposition 25.393 (Commitment without finality). *An economic order can make durable commitments while remaining future-open when the reasons for those commitments are explicit, their relevant scope is specified, and later participants retain institutional capacity to interpret their purpose, repair their consequences, and revise their implementation where revision is materially and normatively admissible.*

Endpoint openness therefore separates decisiveness from finality. Economic institutions must act, invest, prohibit, tax, contract, insure, maintain, and allocate. Openness concerns the status of those commitments within historical time, not an absence of commitment.

25.15.2 Plural Economic Orders

If no universal endpoint is derived from GRE itself, economic futures can contain several possible orders. The relevant plurality is not merely a list of named systems. Economic orders can vary across ownership, coordination, market structure, public provision, fiscal capacity, labor organization, social reproduction, digital infrastructure, ecological governance, knowledge institutions, legal regimes, and distributions of decision authority. Hybrid configurations are common, and the same named institutional category can operate differently under different historical relations.

Definition 25.394 (Possible economic order). A *possible economic order* is a historically and materially specifiable configuration of institutions, relations, capabilities, allocation mechanisms, infrastructures, governance arrangements, value practices, and participation structures that could become sufficiently organized to reproduce and transform economic life under stated conditions.

This definition excludes purely verbal alternatives whose enabling conditions are unspecified. Possibility is graded. Some orders are immediately reachable from a present configuration; others require intermediate institutional development, new capabilities, political coalitions, technologies, ecological conditions, or legal change.

Still others are conceptually imaginable but presently unsupported.

Definition 25.395 (Economic-order possibility set). An *economic-order possibility set* is a bounded, historically situated representation of economic orders and trajectories that are currently reachable, conditionally reachable, latent, or materially foreclosed, together with the transitions and support conditions associated with each status.

The set should not be treated as complete. Novel economic forms can arise through institutional experimentation, technological change, crisis response, social movement, ecological pressure, legal innovation, or recombination of inherited practices. A generative framework therefore includes the capacity to produce later alternatives not represented in the current set.

Proposition 25.396 (Plural-order comparison principle). *Plural economic orders should be compared through their domain-specific consequences, generative mechanisms, distributions of capability and risk, value effects, participation structures, and future-formation properties rather than ranked solely by their proximity to a presupposed terminal model.*

Proposition 25.397 (Plurality non-equivalence condition). *Recognition of several possible economic orders does not imply that the orders are equally adequate, mutually compatible, or normatively interchangeable; plurality preserves the space of comparison while evidence and argument remain responsible for discrimination among alternatives.*

Plurality thus differs from relativism. Some arrangements can be rejected because they predictably destroy capabilities, violate rights, impose severe unreciprocated burdens, generate unsustainable ecological dependence, or entrench domination. Openness requires that such judgments be argued through explicit criteria rather than inferred from an assumed historical destination.

25.15.3 Historical Contingency

Economic orders are formed within histories they do not choose from an empty starting point. Legal categories, infrastructures, property arrangements, fiscal institutions, organizational routines, cultural expectations, technologies, ecological conditions, geopolitical relations, and accumulated capabilities shape what can be imagined and implemented. Historical contingency therefore concerns both realized order and unrealized possibility.

Definition 25.398 (Economic-order contingency profile). An *economic-order contingency profile* records the inherited conditions, sequence-sensitive events, institutional complementarities, capability stocks, path dependencies, critical junctures, external pressures, and unrealized alternatives that materially shaped the emergence and persistence of a specified economic arrangement.

Contingency does not mean causelessness. A contingent order can be strongly constrained by previous events. Nor does it mean that any alternative was historically available. The methodological task is to reconstruct degrees of reachability and the support conditions of unrealized paths, consistent with the historically disciplined option-space inquiry developed earlier in the book.

Definition 25.399 (Historical possibility window). A *historical possibility window* is a temporally bounded configuration in which a specified economic alternative becomes materially more reachable because relevant institutional, political, technolog-

ical, ecological, financial, or social support conditions temporarily align.

Possibility windows can open and close without producing a realized transition. Their existence matters because a later observer can otherwise mistake the surviving order for the only feasible order. Conversely, retrospective imagination can overstate alternatives that lacked contemporaneous support.

Proposition 25.400 (Contingency reconstruction principle). *Claims about alternative economic futures become stronger when they reconstruct the historical conditions that generate reachability, including the capabilities and dependencies inherited from prior paths, rather than treating institutional alternatives as context-free designs.*

Proposition 25.401 (Path inheritance condition). *Future economic openness depends partly on inherited path structures because present arrangements can preserve, deepen, or remove the capabilities, infrastructures, records, and coordination relations needed for later transitions.*

Historical contingency therefore links past and future through generative inheritance. A society does not simply choose among economic systems; it acts from a path-dependent configuration that can itself be modified over time.

25.15.4 Heterogeneous Values

Open economic futures also remain normatively plural. Economic arrangements affect income, security, autonomy, care, ecological integrity, dignity, knowledge, community, cultural continuity, public capability, innovation, resilience, and other values whose relations can be complementary, substitutable, conflicting, or incommensurable. The Chapter 20 analysis of plural-value economic order treated value plurality as an economic problem rather than a residual obstacle. The present subsection draws its future-facing implication: later economic orders should not be assessed through the assumption that one currently dominant value representation exhausts what future participants may reasonably care about.

Definition 25.402 (Future value horizon). *A future value horizon is the set of value structures currently represented as relevant to future economic evaluation together with acknowledged uncertainty about values, interpretations, and forms of significance that later participants may develop or recover.*

The horizon is broader than current preference aggregation. Some values are institutionally weak, difficult to quantify, culturally specific, poorly represented by market exchange, or held by groups with limited present standing. Other values can emerge as technology and social relations change. Preserving a future value horizon therefore requires both representation and epistemic humility.

Definition 25.403 (Value-foreclosure event). *A value-foreclosure event occurs when an economic commitment materially removes the conditions through which a value practice, relation, capability, or form of life could continue or later be reconsidered, especially where the affected value is weakly represented in the decision process.*

Value foreclosure can be warranted in some cases. A society can prohibit a profitable practice because it violates rights or imposes severe harms. The analytical purpose of the concept is to make the loss visible, not to establish an automatic presumption against closure.

Proposition 25.404 (Plural-value future condition). *Future-facing economic evaluation has stronger plural-value adequacy when it preserves materially relevant value*

gains, losses, conversion limits, conflicts, and unrepresented remainder rather than treating one aggregate metric as sufficient evidence of overall improvement.

Proposition 25.405 (Value-horizon revisability). *A future value horizon should remain revisable because later evidence, social experience, ecological change, technological development, and previously marginalized perspectives can alter which values are recognized and how their relations are interpreted.*

Value plurality therefore supports openness without dissolving judgment. The programme can endorse specific protections or priorities while preserving the distinction between a justified present judgment and a complete representation of future value.

25.15.5 Heterogeneous Subjects

Future economic orders will also be inhabited by heterogeneous subjects and relational beings. Earlier chapters distinguished human persons, collective formations, artificial agents, institutions, and non-human positions without assigning them one ontology, phenomenology, utility structure, or moral status. The Chapter 18 analysis of heterogeneous subjects and value structures applied that discipline to AI-mediated economies. The future-facing consequence is that economic design should avoid assuming that one standardized subject model will remain adequate as participants, capabilities, representation systems, and ecological relations change.

Definition 25.406 (Future subject configuration). *A future subject configuration is a historically situated arrangement of subject forms and relational beings that participate in, are represented by, are affected by, or exercise consequential agency within an economic order, together with their differentiated capacities, dependencies, standing, representation channels, and value relations.*

The category is intentionally wider than the model of an individual market actor. Households, firms, communities, public bodies, ecosystems represented through institutions, artificial agents, future persons represented by present fiduciary structures, and other collectives can enter economic relations in different ways. Their standing should be specified rather than inferred from nominal inclusion in a common category.

Definition 25.407 (Subject-representation gap). *A subject-representation gap is the difference between the set of positions materially affected by an economic arrangement and the set of positions whose interests, values, knowledge, or claims are effectively represented in the processes that form or revise that arrangement.*

Representation gaps are future-formative because excluded positions can bear costs that later narrow social possibility. Ecological degradation borne outside the decision boundary, unpaid care displaced from formal accounting, or technical dependence imposed on users without effective exit can alter later capabilities even when the affected positions were weakly represented at the moment of decision.

Proposition 25.408 (Heterogeneous-subject standing principle). *The standing of heterogeneous subjects in future economic analysis should be justified through the relevant legal, ethical, relational, institutional, and empirical arguments rather than inferred from a single model of agency or utility.*

Proposition 25.409 (Representation-gap effect). *A persistent subject-representation gap can reduce future openness when the unrepresented consequences it permits degrade capabilities, relations, ecological conditions, institutional trust, or option struc-*

tures required for later participation and revision.

Heterogeneous subjecthood thus links inclusion to future formation. The question is not simply who is counted in the present economy, but whose continued capacity to participate in later economic formation is generated or depleted by present arrangements.

25.15.6 Generative Participation

The Chapter 20 analysis of economic participation treated participation as more than employment, exchange, or formal membership. For open futures, the relevant threshold is stronger: participants require some practical relation to the processes through which later economic options, institutions, knowledge, infrastructures, and value arrangements are formed. Formal voice can coexist with weak generative influence when agenda control, technical capability, finance, information, or institutional access remains highly concentrated.

Definition 25.410 (Future-forming participation). *Future-forming participation* is the practical capacity of a subject or collective to contribute to, contest, initiate, maintain, redirect, or terminate processes that materially shape later economic relations, institutions, capabilities, infrastructures, values, and reachable alternatives.

Future-forming participation can occur through work, entrepreneurship, care, research, public administration, community organization, political action, maintenance, standard setting, investment, education, technical development, legal contestation, or other pathways. The relevant form depends on the domain. Participation therefore cannot be reduced to one institutional procedure.

Definition 25.411 (Generative-participation distribution). A *generative-participation distribution* records how future-forming capacities are distributed across positions, including access to agenda formation, knowledge, finance, infrastructure, coordination, experimentation, maintenance, contestation, and recognized decision authority.

This distribution can differ substantially from the distribution of present consumption or income. A group can receive material benefits while remaining unable to shape the infrastructure on which those benefits depend. Another actor can have modest current consumption but substantial authority over standards, data, capital allocation, or platform design that structure later possibility.

Proposition 25.412 (Participation-consequence condition). *Participation contributes more strongly to future openness when participants possess practicable pathways through which their knowledge, claims, experimentation, maintenance, and contestation can alter consequential economic processes rather than remaining merely consultative or symbolic.*

Proposition 25.413 (Generative participation non-uniformity). *Open economic futures do not require identical future-forming authority for every subject in every domain, but material concentrations of generative participation should remain visible and contestable where they structure the opportunities and dependencies of others.*

The second proposition prevents participation from becoming an undifferentiated equality requirement. Expertise, delegated authority, fiduciary responsibility, emergency powers, and differentiated institutional roles can be legitimate. The future-formative concern is whether concentrated authority becomes self-reinforcing, unreviewable, or capable of foreclosing the conditions under which affected positions can

later challenge it.

25.15.7 Option Preservation

Future openness requires some possibilities to remain materially reachable across time. The Chapter 20 future-formation analysis distinguished option preservation from maximizing the number of options. The present subsection emphasizes its programme-level role: preserving selected capabilities and transition pathways can be valuable precisely because current actors cannot exhaustively know which future combinations of values, technologies, risks, and institutions later participants will face.

Definition 25.414 (Generative option preservation). *Generative option preservation* is the maintenance of capabilities, infrastructures, knowledge, ecological conditions, institutional permissions, interoperability, reserves, or transition pathways that keep specified classes of later economic action practically reachable or allow new options to be generated.

Preservation can concern redundancy in infrastructure, maintenance of public capability, ecological buffers, diversified knowledge, interoperable standards, retraining capacity, archives, legal pathways for institutional innovation, or the continued existence of organizations able to develop alternatives. Its object is therefore broader than keeping a menu item formally available.

Definition 25.415 (Option-preservation burden). An *option-preservation burden* is the material, institutional, ecological, fiscal, organizational, or opportunity cost required to maintain a future option or class of options at a specified level of practical reachability.

Not every option warrants its burden. Maintaining obsolete infrastructure can consume resources needed for safer or more inclusive alternatives. Preserving a harmful practice because it is an “option” can impose unacceptable costs on others. Option preservation therefore requires evaluation of consequences, standing, scarcity, substitutability, and irreversibility.

Definition 25.416 (Foreclosure significance profile). A *foreclosure significance profile* records the possibilities removed by a proposed commitment, affected positions, substitutable and non-substitutable losses, expected duration, reversibility, path dependencies created, capabilities lost, reasons for closure, and the degree of uncertainty concerning later value.

Proposition 25.417 (Selective option-preservation principle). *Option preservation is warranted selectively rather than maximally: priority is stronger where foreclosure is difficult to reverse, later value is materially uncertain, the option supports broad path-creation capacity, and preservation costs are proportionate to the consequences of irreversible loss.*

Proposition 25.418 (Capability-before-catalogue condition). *The preservation of capabilities that can generate several later pathways can provide greater future openness than preserving a large catalogue of nominal options whose practical support conditions are weak or dependent on a single fragile structure.*

Option preservation therefore focuses attention on generative substrates. Education, repair capability, institutional memory, ecological resilience, open standards, and public coordination capacity can preserve classes of possibility that current deci-

sion makers cannot enumerate in advance.

25.15.8 Future Revisability

The final dimension concerns the capacity of later participants to reconsider inherited order. Revisability does not imply that every consequence can be undone. Infrastructure ages, ecological losses can be irreversible, institutions create expectations, contracts generate reliance, skills decay, and technological standards accumulate complements. The relevant question is whether an economic order preserves practical mechanisms for learning and correction where revision remains possible and whether unavoidable irreversibilities are made explicit before they are imposed.

Definition 25.419 (Economic future revisability). *Economic future revisability* is the practical capacity of later participants to reassess inherited economic arrangements, recover the reasons and evidence behind them, contest their continuation, repair harmful consequences, alter implementation, create successor institutions, or redirect trajectories where material and normative conditions permit change.

Revisability depends on more than formal amendment rules. It can require archives, data continuity, legal standing, organizational competence, fiscal capacity, interoperable infrastructure, plural expertise, maintenance knowledge, and institutions capable of carrying transitions without catastrophic loss of essential functions. The preservation and provenance architecture of Section 25.10 is therefore directly relevant to economic order: arrangements that cannot be reconstructed are harder to revise intelligently.

Definition 25.420 (Revision-capacity profile). A *revision-capacity profile* records the legal, institutional, epistemic, technical, fiscal, organizational, and participatory capacities through which an inherited economic arrangement can be reviewed, modified, repaired, replaced, or succeeded, together with the irreversibilities and dependencies that limit those operations.

Definition 25.421 (Irreversibility disclosure). An *irreversibility disclosure* identifies, before or during a consequential economic commitment, the known and materially plausible losses, lock-ins, dependency accumulations, ecological thresholds, capability erosions, or institutional closures that could make later revision substantially more difficult or impossible.

The disclosure does not eliminate uncertainty. It makes the expected asymmetry between commitment and reversal part of present evaluation.

Proposition 25.422 (Future-revisability condition). *An economic arrangement contributes more strongly to an open generative future when its important commitments are accompanied, where feasible, by records, review pathways, repair capacity, successor capacity, and distributed standing sufficient for later participants to reconsider inherited arrangements in light of changed evidence, values, technologies, and historical conditions.*

Proposition 25.423 (Irreversibility accountability principle). *Where an economic commitment predictably creates severe or durable irreversibility, future openness requires stronger present justification and clearer accounting of affected positions, alternatives considered, preservation losses, and the reasons that reversible or staged pathways were judged inadequate.*

Definition 25.424 (Open-economic-future portfolio). An *open-economic-future port-*

folio is a versioned programme record that links endpoint assumptions, possible economic orders, contingency profiles, future value horizons, future subject configurations, generative-participation distributions, option-preservation decisions, foreclosure significance profiles, revision-capacity profiles, and irreversibility disclosures for a specified economic setting.

The portfolio is not a planning algorithm. It is a discipline for keeping the future-formative consequences of economic order visible. It allows researchers and practitioners to distinguish a present recommendation from a claim about historical destiny, a plural possibility field from an assertion of equivalence, participation from consequential future-forming capacity, and option preservation from indiscriminate delay.

Proposition 25.425 (Open generative future principle). *GRE supports the analysis of open generative economic futures when present arrangements are evaluated not only by current outputs but also by the value plurality, subject standing, participation pathways, generative capabilities, option structures, irreversible losses, and revision capacities they create for later economic formation.*

The principle does not turn openness into the sole economic value. Stability, security, justice, ecological protection, reliability, care, coordination, and other values can justify commitments that narrow possibility. Its contribution is to make one additional class of consequences explicit: economic decisions help constitute the future field within which later participants can know, value, coordinate, contest, create, and revise. An open generative future is therefore neither a final system nor an indefinitely postponed decision. It is a historically situated economic order whose closures remain accountable to the capabilities and relations through which economic futures continue to be formed.

The next section turns from the character of possible economic futures to the research attention required to study them. It identifies the relations, generative conditions, histories, manifestations, positions, value plurality, power, and foreclosed possibilities that GRE asks researchers to keep analytically visible.

25.16 Research Attention in Generative Relational Economics

The preceding sections have described GRE as a revisable programme, specified its openness to domain evidence, disciplined cross-domain learning, and treated both theoretical development and economic futures as historically open. The present section turns from programme architecture to research attention. Its role is to state which kinds of objects a GRE inquiry is expected to keep analytically visible when formulating questions, selecting evidence, constructing representations, and interpreting results. Its objective is not to provide an exhaustive checklist or to claim that every research project must study every object at equal depth. It instead identifies eight recurring attentional commitments that help distinguish a generative-relational investigation from an analysis that treats economic entities, values, observations, or outcomes as self-contained. The section develops relations, generative conditions, conversion, circulation, historical position, value plurality, power, and foreclosed possibilities. The method is diagnostic and inferential: each attentional object is paired with the kinds of omissions or overextensions that can distort interpretation.

Research attention matters because what becomes visible in an inquiry partly depends on what the inquiry is prepared to represent. An entity-centred dataset can be entirely adequate for a narrowly specified question while remaining unable to represent the relation through which an observed state was produced. A measured transfer can record an amount while omitting the conversion by which one kind of value became another. A historically later observer can possess evidence unavailable to contemporaneous actors and thereby misread past action as if later knowledge had already been accessible. A formally available option can appear preserved even when power, capability, or institutional dependence makes the option practically unreachable. GRE therefore treats attentional design as part of research design rather than as a stylistic supplement added after analysis.

Definition 25.426 (GRE research-attention profile). *A GRE research-attention profile records, for a specified research question, which relational structures, generative conditions, conversion processes, circulation paths, historical positions, value forms, power relations, and possibility foreclosures are treated as analytically relevant; which are represented directly, indirectly, or not at all; and what inferential limitations follow from those choices.*

The profile is intentionally question-relative. A price-elasticity estimate, archival reconstruction, institutional case study, network model, legal-economic analysis, or ethnographic inquiry can each have a different adequate profile. The GRE requirement is not maximal inclusion. It is explicitness about which consequential relational and generative objects remain outside the chosen representation.

Definition 25.427 (Attentional omission). *An attentional omission occurs when an analytically consequential object, relation, process, position, or unrealized possibility is absent from a research representation in a way that can materially alter the interpretation, scope, or warrant of the resulting claim.*

An omission is therefore different from an ordinary boundary of scope. A study can responsibly exclude many objects. The problem arises when an excluded object bears directly on the inference being made and the exclusion is left unexamined.

Proposition 25.428 (Research-attention sufficiency condition). *A GRE research-attention profile is sufficient for a stated inquiry when it represents, or explicitly bounds, the relational and generative objects whose omission could materially change the intended inference, while avoiding the claim that the resulting profile exhausts the economic situation.*

Table 25.16 summarizes the eight attentional objects developed below and the principal inferential risk associated with neglecting each one.

Proposition 25.429 (Attentional non-exhaustiveness principle). *The eight objects in the present section define a recurring GRE research orientation rather than a closed ontology or universal template; additional domain-specific objects should take priority whenever they are necessary for adequate inquiry.*

25.16.1 Relations

GRE begins research attention with relations because many economically consequential properties depend on structured connections among persons, organizations, institutions, technologies, environments, rules, representations, and historical inheritances. The relevant relation can be contractual, legal, organizational, epistemic, in-

Table 25.16: Research-attention objects in GRE and their principal inferential risks

Attention object	Principal research concern	Principal inferential risk when omitted
Relations	Dependence, interaction, mediation, and co-constitution among economic objects	Treating relationally produced properties as intrinsic or independent
Generative conditions	Conditions that enable, constrain, reproduce, or transform later possibilities	Reading observed outcomes without the conditions that made them reachable
Conversion	Transformation among heterogeneous resources, values, capacities, rights, or representations	Treating transformation as frictionless equivalence or simple transfer
Circulation	Movement, interruption, return, capture, dissipation, and regeneration	Inferring system-wide movement from one local transfer or transaction
Historical position	Temporal, institutional, evidential, and conceptual location of observer and observed actors	Projecting later categories, knowledge, or possibilities into earlier situations
Value plurality	Coexisting evaluative forms and partial or absent commensurability	Hiding value-specific gains, losses, and remainder through premature aggregation
Power	Typed asymmetry, relational realization, agenda effects, and control over interfaces	Inferring voluntariness or neutrality from formally available choices
Foreclosed possibilities	Alternatives made unreachable, unintelligible, unaffordable, or institutionally unavailable	Treating the observed path as if it represented the relevant possibility field

frastructural, ecological, symbolic, affective, technical, political, or otherwise domain-specific. Relational attention does not require replacing entities with relations. It requires asking which apparently entity-level properties are produced, sustained, or altered through relations and which entity boundaries are themselves consequential products of relational organization.

Definition 25.430 (Relational unit of inquiry). A *relational unit of inquiry* is a research object specified together with the relations, counterparties, mediating structures, and boundary conditions required to interpret the property or process under investigation.

A firm studied as a relational unit may require attention to workers, suppliers, creditors, customers, regulators, standards, infrastructures, ownership arrangements, and ecological dependencies. A household may require attention to care relations, legal status, income flows, kinship, housing, public provision, and unpaid work. The appropriate unit remains question-dependent; GRE does not presume that every possible relation belongs in every study.

Definition 25.431 (Relation specification). A *relation specification* records the relation relevant to a research question, the type of relation among them, its directionality or reciprocity where applicable, its temporal extent, mediating institutions or representations, and the evidence through which the relation is inferred.

Relation specification protects against vague relationalism. Merely asserting that “everything is related” supplies little analytical content. A useful relational claim identifies which relation matters, by what mechanism or interpretive pathway it matters, and what evidence could revise the claim.

Definition 25.432 (Relational attribution error). A *relational attribution error* occurs when a property substantially generated or sustained through specified relations is attributed to an entity as if the property were independent of those relations for the purpose of the inference being made.

Examples can include treating creditworthiness as wholly individual when it depends on institutional scoring systems and labor-market position, treating market access as a simple possession when access depends on infrastructure and legal standing, or treating organizational productivity as separable from coordination and knowledge relations. The diagnosis remains empirical: some properties may be relatively robust across relational changes, while others can be highly relation-dependent.

Proposition 25.433 (Relational-attention condition). *When a target property changes materially with the structure, quality, or availability of relevant relations, a GRE analysis should represent those relations or limit its claim so that the property is not interpreted as relation-independent.*

Relational attention also concerns relations among mechanisms. A policy can alter a financial relation, which changes organizational bargaining, which changes labor conditions, which changes household capacity. The relation between mechanisms can itself be part of the economic object rather than a complication to be removed in advance.

25.16.2 Generative Conditions

Observed economic outcomes do not reveal by themselves the conditions that made those outcomes reachable. GRE therefore asks researchers to attend to generative conditions: arrangements that enable, constrain, reproduce, redirect, or suppress the production of later relations, capacities, institutions, values, and possibilities. This attention differs from a search for one sufficient cause. A generative condition can be necessary in one domain, enabling in another, probabilistically supportive in a third, or merely one component of a larger conjuncture.

Definition 25.434 (Generative-condition set). A *generative-condition set* is a research-specified collection of historically situated material, institutional, relational, epistemic, normative, ecological, or technological conditions whose presence, configuration, or interaction bears on the production or reproduction of the target process under study.

The set should be treated as provisional. New evidence can reveal omitted conditions, while comparative work can show that a condition important in one setting is substitutable or irrelevant in another.

Definition 25.435 (Possibility-conditioning profile). A *possibility-conditioning profile* records how identified conditions expand, narrow, differentiate, stabilize, or reorganize the set of practically reachable states, actions, relations, or institutional arrangements relevant to a research question.

The profile shifts attention from outcome occurrence alone to structured reachability. Two populations can display the same current outcome while facing very differ-

ent future possibility fields. Conversely, the same formal opportunity can generate different practical possibilities when capabilities, relations, information, or institutional access differ.

Proposition 25.436 (Generative-conditionality principle). *A GRE explanation of a generated outcome should identify the conditions that make the proposed generative pathway plausible and should avoid treating the observed outcome as sufficient evidence that those conditions were present in the form assumed by the explanation.*

Proposition 25.437 (Generative non-determinism condition). *The identification of a generative condition does not by itself establish deterministic production of the associated outcome; the warranted claim depends on the mechanism, evidence, competing conditions, stochastic structure, and historical scope of the case.*

Generative attention therefore joins explanation to counterfactual discipline. Researchers should ask not only what occurred, but which conditions allowed the occurrence, what alternative conditions might have produced similar outcomes, and what changes in those conditions would alter later possibility formation.

25.16.3 Conversion

Economic processes frequently transform one kind of object into another: money into access, credentials into employment opportunities, labor into income, data into prediction, legal rights into practical claims, social recognition into cooperation, infrastructure into mobility, or ecological capacity into production. GRE uses conversion attention to prevent these transformations from being represented as if heterogeneous inputs and outputs were already commensurable or as if transfer automatically preserved meaning and value.

Definition 25.438 (Conversion event record). *A conversion event record specifies a transformation in which an input resource, value, capacity, right, representation, or relational position contributes to an output of a different analytical type, together with the conversion mechanism, participating actors or institutions, enabling conditions, losses, gains, uncertainty, and non-converted remainder.*

The record can be qualitative, quantitative, formal, historical, or mixed. What matters is that conversion be made visible as a process rather than hidden inside an assumed equivalence.

Definition 25.439 (Conversion interface). *A conversion interface is the relational and institutional site through which a conversion is enabled, evaluated, authorized, priced, constrained, or denied.*

Interfaces include markets, credentialing systems, eligibility rules, payment infrastructures, organizational procedures, technical standards, algorithms, legal processes, and social norms. Control over an interface can therefore influence which forms of value or capacity become convertible and on what terms.

Definition 25.440 (Conversion remainder). *A conversion remainder is the portion of meaning, value, capacity, risk, obligation, or relational significance that is not preserved by the conversion representation used in an analysis.*

Remainder does not imply that conversion is illegitimate. Monetary valuation, scoring, indexing, legal classification, and statistical aggregation can be indispensable. The analytical requirement is to distinguish a useful conversion from a complete equivalence claim.

Proposition 25.441 (Conversion-attention principle). *When an inference depends on movement between analytically heterogeneous forms, a GRE analysis should identify the conversion interface and preserve materially relevant conversion remainder rather than treating the input and output as interchangeable by default.*

Conversion attention also creates an interface with power analysis. If one actor can set the admissible units, thresholds, categories, or exchange terms through which heterogeneous objects become convertible, then the conversion process can itself become a site of economic power rather than a neutral technical step.

25.16.4 Circulation

A transfer observed at one point in an economic process does not establish that value, resources, information, or capacity circulate through the wider system. GRE therefore asks researchers to trace movement beyond the focal transaction where the research question requires it. Circulation attention concerns pathways of movement, interruption, accumulation, return, capture, dissipation, and regeneration. It is particularly important when policy or institutional evaluation assumes that an initial allocation will propagate benefits through later relations.

Definition 25.442 (Circulation path). *A circulation path is a temporally ordered sequence of transfers, conversions, uses, returns, or relational changes through which a specified economic object or effect moves across actors, institutions, locations, or value forms.*

The identity of the moving object may change along the path. A grant can become wages, purchased services, knowledge, infrastructure, institutional capacity, or later revenue. A circulation analysis should therefore distinguish continuity of causal or relational contribution from identity of substance.

Definition 25.443 (Circulation interruption). *A circulation interruption is a point at which an expected or hypothesized movement is blocked, captured, dissipated, delayed, redirected, or transformed so that the downstream path differs materially from the one assumed by the research model.*

Interruption can be a failure, a legitimate retention, a protective barrier, or a productive transformation. The term is descriptive. Its normative significance depends on the purpose of the circulation and the values affected.

Definition 25.444 (Return-regeneration relation). *A return-regeneration relation records whether and how a circulation path contributes back to the capacities, relations, institutions, communities, infrastructures, or ecological conditions from which later generative activity can continue.*

This relation helps distinguish extraction from circulation that supports renewal, while avoiding the assumption that every economic process should literally return resources to its point of origin.

Proposition 25.445 (Local-transfer non-completion principle). *Evidence of a local transfer or conversion does not by itself establish successful circulation, downstream realization, return, or regeneration; those later relations require their own evidence or an explicitly limited claim.*

Circulation attention is therefore especially useful for identifying where a promising intervention ceases to have the effect attributed to it. It can also reveal that apparent leakage at one level is productive circulation at another, which is why the relevant

system boundary must remain explicit.

25.16.5 Historical Position

GRE treats economic knowledge as historically positioned. Researchers observe past and present economic objects from particular temporal, institutional, conceptual, technological, and evidential locations. Historical position shapes which categories appear natural, which records survive, which alternatives are visible, which actors can speak in the archive, and which later outcomes are already known to the researcher. Attention to historical position does not make knowledge arbitrary. It makes the conditions of knowledge part of the inquiry.

Definition 25.446 (Research-position profile). A *research-position profile* records the temporal location, institutional setting, conceptual vocabulary, available evidence, methodological instruments, and relevant social or technological conditions from which a researcher constructs an interpretation of the target economic object.

The profile can also record positional advantages and blind spots. A later researcher may possess longitudinal data unavailable to contemporaries while lacking tacit knowledge that was obvious to participants. An institutionally embedded researcher may gain access while facing organizational constraints on interpretation. These conditions affect warrant in different ways.

Definition 25.447 (Contemporaneous accessibility boundary). A *contemporaneous accessibility boundary* distinguishes information, concepts, alternatives, technologies, and causal knowledge reasonably available to actors at the historical moment under study from those that became available only later or were available only to differently positioned actors.

The boundary is often heterogeneous rather than universal. Elites, administrators, workers, households, communities, and external observers can occupy different epistemic positions within the same period.

Definition 25.448 (Retrospective projection error). A *retrospective projection error* occurs when later knowledge, categories, institutional possibilities, or normative settlements are attributed to earlier actors or situations in a way that materially distorts the interpretation of their available choices, beliefs, or constraints.

Proposition 25.449 (Historical-position disclosure principle). *When a GRE inference depends materially on later evidence, later categories, or a historically specific research position, the analysis should disclose that dependence and distinguish retrospective reconstruction from contemporaneously available understanding.*

Historical-position attention also applies to present research. Categories such as platform, labor, household, intelligence, risk, property, market, or public interest can shift as institutions and technologies change. The researcher should therefore preserve concept provenance where category change could alter the object being compared across time.

25.16.6 Value Plurality

Economic inquiry often requires evaluation across several forms of value whose relations are partial, contested, context-dependent, or absent. GRE asks researchers to notice when a common metric is doing analytical work and when it is silently con-

verting a plural evaluative field into a single scale. Value plurality does not prohibit aggregation. It requires an account of what the aggregation preserves, what it excludes, and which judgments authorize the conversion.

Definition 25.450 (Research value register). A *research value register* records the value forms materially relevant to a research question, the subjects or communities for whom they matter, the evidence through which they are represented, and the known relations of comparability, conversion, conflict, complementarity, or incommensurability among them.

The register can include monetary, welfare, capability, ecological, legal, cultural, epistemic, relational, aesthetic, care-related, or other domain-specific values. Inclusion depends on the question and evidence rather than on a fixed GRE taxonomy.

Definition 25.451 (Commensuration event). A *commensuration event* is an analytical, institutional, political, or practical act through which heterogeneous value forms are placed on a shared ordering, metric, threshold, score, or decision rule for a specified purpose.

Commensuration is itself an object of inquiry. It can make decision possible, reveal trade-offs, or support accountability. It can also suppress value dimensions that do not fit the chosen representation or assign authority to those who control the metric.

Definition 25.452 (Value-attention remainder). A *value-attention remainder* is a materially relevant value claim, loss, gain, conflict, or evaluative perspective that remains outside or only partially represented by the metric or comparison used in a study.

Proposition 25.453 (Plural-value attention condition). *When a research conclusion depends on aggregating, comparing, or converting heterogeneous value forms, a GRE analysis should make the governing commensuration rule visible and retain materially relevant value-attention remainder in the interpretation of the result.*

This condition protects against a common inferential shortcut: a result can be optimal under one metric while imposing severe losses in another value domain. GRE does not determine in advance how such conflicts should be settled. It requires that the conflict remain analytically visible until an explicit evaluative or institutional argument addresses it.

25.16.7 Power

Power attention asks how differentiated capacities become relationally realized in the economic situation under study. The book has distinguished typed asymmetry from power relevance and from realized power relations. The research implication is that neither equality nor domination should be inferred from a single scalar difference. Researchers should identify the relevant asymmetry, the relation through which it becomes consequential, the mechanism by which alternatives or outcomes are shaped, and the evidence available for that mechanism.

Definition 25.454 (Research-facing power trace). A *research-facing power trace* is an evidentially supported indication that a typed asymmetry is relationally realized through agenda setting, access control, conversion control, dependence, sanction capacity, information control, institutional authority, infrastructural position, option shaping, or another specified mechanism relevant to the research question.

A trace is weaker than a complete theory of power. Its purpose is to prevent power

from disappearing merely because the research representation contains voluntary transactions, formal equality, or aggregate outcomes.

Definition 25.455 (Power-sensitive inference check). A *power-sensitive inference check* asks whether the observed choices, exchanges, classifications, or outcomes would support the same interpretation if the relevant asymmetries, dependencies, agenda controls, exit capacities, and interface controls were materially different.

The check can reveal where an apparently preference-based outcome depends on constrained alternatives, where a market price depends on concentrated bargaining position, or where a classification reflects authority over the categories through which participation is recognized.

Definition 25.456 (Observational power effect). An *observational power effect* occurs when power relations materially shape what evidence becomes available, whose testimony is recorded, which categories are institutionally recognized, what data are collected, or which outcomes become legible to the research process.

Power can therefore operate on the object of study and on the evidential field through which that object is known. This does not imply that marginalized evidence is automatically correct or institutional evidence automatically distorted. It requires that asymmetries in evidence production be considered where they affect inference.

Proposition 25.457 (Power-attention condition). *When a GRE claim concerns choice, participation, exchange, access, conversion, institutional response, or distribution under materially relevant asymmetry, the analysis should examine whether and how that asymmetry becomes relationally realized before interpreting the observed outcome as evidence of unconstrained preference or neutral coordination.*

Power attention also connects to reflexivity. Research classifications, rankings, and measurements can enter the economic field and alter behavior, access, or expectations. Where such feedback is material, the research object includes the relation between observation and the transformed field rather than only the pre-observation state.

25.16.8 Foreclosed Possibilities

The final attentional object concerns possibilities that do not appear among observed choices because they have already been made unreachable, unintelligible, unaffordable, institutionally inadmissible, technologically unavailable, or socially unsustainable. Section 25.15 treated option preservation and future revisability as dimensions of open generative economic futures. The research-facing implication is that the observed path should not automatically be treated as evidence for the full possibility field from which actors could choose.

Definition 25.458 (Foreclosure trace). A *foreclosure trace* is evidence that a previously possible, potentially constructible, or relevantly imaginable economic path has become practically unreachable or materially harder to reach through institutional commitment, resource depletion, capability loss, legal restriction, infrastructural lock-in, power concentration, ecological change, knowledge loss, or another specified mechanism.

Not every foreclosure is undesirable. Safety rules can foreclose hazardous practices; rights can remove discriminatory options; ecological constraints can properly prohibit destructive uses. Research attention is required because the act of foreclo-

sure changes the possibility structure and can distribute benefits, losses, and revision capacity unevenly.

Definition 25.459 (Relevant possibility horizon). A *relevant possibility horizon* is the research-bounded set of alternatives that are historically plausible, institutionally or technically constructible, or sufficiently grounded in evidence to matter for evaluating the observed economic path.

The horizon is intentionally narrower than an unrestricted set of imaginable worlds. Counterfactual analysis gains discipline when alternatives are connected to historical conditions, capabilities, institutional designs, or evidenced pathways rather than introduced solely because they are logically conceivable.

Definition 25.460 (Silent foreclosure). A *silent foreclosure* occurs when an analysis treats the absence of an option from observed choice or institutional practice as evidence of irrelevance even though the option's absence is materially explained by earlier constraints, suppression, capability loss, or unrepresented path dependence.

Silent foreclosure can bias causal and normative inference. If a community cannot select an institutional alternative because it lacks legal authority or implementation capacity, non-selection is weak evidence against the alternative's desirability. If an industry lacks a low-carbon pathway because earlier infrastructure investment locked in another technology, current cost comparisons can embed the history that produced the cost structure.

Definition 25.461 (Research possibility-loss record). A *research possibility-loss record* identifies a relevant foreclosed possibility, the mechanism and timing of foreclosure, affected subjects and value forms, available evidence, residual pathways of recovery or substitution, and the uncertainty surrounding the counterfactual assessment.

Proposition 25.462 (Observed-path non-exhaustiveness principle). *An observed economic path should not be interpreted as exhausting the relevant possibility horizon when evidence indicates that consequential alternatives were foreclosed before, or during, the period in which observed choices were made.*

The principle does not require speculative reconstruction of every unrealized alternative. It requires attention to foreclosures that are evidenced strongly enough to affect the interpretation of the path that did occur.

Definition 25.463 (GRE research-attention portfolio). A *GRE research-attention portfolio* is a project-level record that connects the research question to its relational units, generative-condition sets, conversion interfaces, circulation paths, research-position profile, value register, power traces, and relevant possibility-loss records, while documenting omissions, uncertainty, and domain-specific additions.

The portfolio is not a mandatory reporting form. It is a conceptual device for asking whether the research design has preserved the objects on which its own inference depends. In a small study, several components may be brief or explicitly out of scope. In a large programme, the same components may be distributed across methods, datasets, historical work, formal models, and collaborative disciplines.

Proposition 25.464 (Research-attention integration principle). *GRE research is most consistent with the programme developed in this book when its claims remain traceable to the relations, generative conditions, conversions, circulation paths, historical positions, value structures, power mechanisms, and relevant foreclosures that materially condition those claims, while the limits of the chosen representation remain explicit and revisable.*

This integration principle closes the researcher-facing synthesis without turning GRE into a compulsory method. Different questions will require different methods and different attentional depth. The programme contribution is a discipline of visibility: relations should not disappear behind isolated entities, generative conditions behind outcomes, conversions behind commensurated numbers, circulation behind local transfers, historical position behind retrospective certainty, value plurality behind a single metric, power behind formally available choice, or foreclosed possibilities behind the path that happened to remain observable. The next section will translate the same programme orientation into the distinct problem of practical action, where decisions must often be made before comparable evidential completeness is available.

25.17 Practitioner Attention in Generative Relational Economics

Section 25.16 translated GRE's open-programme architecture into a discipline of research attention. The present section turns to practical action. Its role is to identify the recurring objects that practitioners should keep visible when decisions must be made before evidence is complete and when action itself can alter the relational field being evaluated. Its objective is neither to provide a universal decision procedure nor to imply that practical judgment can be reduced to a checklist. It develops eight practitioner-facing attentional objects: incomplete knowledge, relational consequences, long-horizon effects, reversibility, participation, value conflict, power asymmetry, and learning through action. The method is action-conditional and reflexive. Each object is treated as a feature of a practical situation that can affect the warrant, legitimacy, adaptability, or downstream consequences of intervention.

The distinction from research attention is important. Researchers can sometimes narrow a question until the available evidence supports a defensible inference. Practitioners often face a different constraint: postponement can itself have consequences, institutional windows can close, harms can accumulate, budgets can expire, technologies can diffuse, and affected subjects can be required to live with an arrangement before its effects are well understood. Practical action therefore cannot generally be conditioned on complete knowledge. At the same time, uncertainty does not remove responsibility for how an intervention redistributes relationships, capabilities, exposure, participation, and future options. GRE treats this combination as a problem of situated action under epistemic and relational incompleteness.

Definition 25.465 (GRE practitioner-attention profile). A *GRE practitioner-attention profile* records, for a specified decision or intervention, the material uncertainties, relational consequences, time horizons, reversibility conditions, participation structure, value conflicts, power asymmetries, and learning channels that are relevant to acting and revising action in that situation.

The profile is action-relative rather than exhaustive. A monetary-policy decision, school reform, platform rule, procurement choice, community programme, ecological restoration project, organizational redesign, or household intervention can require different levels of attention to each dimension. The GRE requirement is not that every practical situation be modeled with equal complexity. It is that dimensions capable of materially changing the consequences or legitimacy of action should not

Table 25.17: Practitioner-attention objects in GRE and their principal practical risks

Attention object	Principal practical concern	Principal risk when neglected
Incomplete knowledge	Acting while causal, distributive, or contextual knowledge remains partial	Treating uncertainty as certainty, or paralysis as epistemic caution
Relational consequences	Changes in dependence, trust, coordination, access, identity, and institutional position	Evaluating only immediate outputs while the relational field is being altered
Long-horizon effects	Delayed, cumulative, path-dependent, intergenerational, and regenerative consequences	Optimizing a short horizon while transferring costs or fragility into later periods
Reversibility	Capacity to stop, repair, compensate, redesign, or exit an intervention	Treating formally reversible action as practically recoverable when restoration is costly or impossible
Participation	Who can enter, contest, shape, implement, monitor, and revise action	Confusing consultation or formal access with consequential participation
Value conflict	Heterogeneous gains, losses, claims, and non-equivalent values	Hiding distributive or normative conflict inside one metric or aggregate objective
Power asymmetry	Unequal capacity to set agendas, control interfaces, impose costs, or refuse terms	Treating consent, choice, or implementation as neutral where dependencies structure the field
Learning through action	Feedback, monitoring, adaptation, and revision generated by intervention	Repeating error or scaling uncertainty without preserving the conditions for learning

disappear merely because they are difficult to quantify.

Definition 25.466 (Practical attentional omission). A *practical attentional omission* occurs when a materially consequential uncertainty, relation, delayed effect, reversibility condition, affected participant, value conflict, power mechanism, or learning opportunity is excluded from practical reasoning in a way that can alter the decision, its implementation, or its capacity for later correction.

A practical omission is distinct from ordinary simplification. Action always requires selection. The relevant question is whether the omitted object is sufficiently consequential that treating it as absent produces an avoidable distortion of the action situation.

Proposition 25.467 (Practitioner-attention sufficiency condition). A *practitioner-attention profile* is sufficient for a specified intervention when it represents, or explicitly bounds, the uncertainties and relational consequences capable of materially changing the action's expected effects, legitimacy, reversibility, or revision pathway, without claiming that the resulting representation exhausts the practical situation.

Table 25.17 summarizes the eight practitioner-facing objects and the principal practical risk associated with neglecting each one.

Proposition 25.468 (Practical non-exhaustiveness principle). The eight objects in the present section define a recurring GRE practitioner orientation rather than a complete

ethics of action, policy algorithm, or universal governance template; domain-specific legal, technical, ecological, medical, safety, cultural, or professional requirements retain priority where they govern the action in question.

25.17.1 Incomplete Knowledge

Practical action often occurs before the relevant causal structure, future environment, distributional effect, or implementation response is fully known. GRE therefore asks practitioners to distinguish what is known, what is uncertain, what is presently unknowable, and what could be learned only by acting or observing further. This distinction supports neither reckless action nor indefinite postponement. It makes the epistemic condition of the decision visible so that the intervention can be proportioned to the quality of its warrant and the cost of error.

Definition 25.469 (Practical uncertainty register). A *practical uncertainty register* records the claims on which an intervention depends, the available evidence for each claim, the principal unresolved uncertainties, plausible alternative interpretations, the consequences of being wrong, and the conditions under which new evidence would justify changing course.

The register can contain quantitative uncertainty where estimation is possible, but it also includes structural uncertainty, model uncertainty, interpretive disagreement, unknown implementation responses, and uncertainty about which value dimensions will become salient after intervention. Treating every uncertainty as a probability distribution can create false precision; leaving uncertainty wholly unstructured can create equally serious opacity.

Definition 25.470 (Decision deadline). A *decision deadline* is the latest practically relevant point at which an actor can defer a decision without materially changing the available options, expected harms, institutional conditions, or opportunity structure of the action situation.

The deadline can be externally imposed or generated by the situation itself. A disease outbreak, ecological threshold, budget cycle, contract expiry, rapidly diffusing technology, or accumulating infrastructural failure can make waiting consequential. Conversely, artificial urgency can be used strategically to suppress scrutiny. The practical question is therefore whether the deadline is itself well grounded.

Definition 25.471 (Epistemic action threshold). An *epistemic action threshold* is the context-specific level and type of warrant judged sufficient to permit a specified action given the action's stakes, reversibility, urgency, available alternatives, and expected distribution of error costs.

The threshold should normally be higher for interventions that are difficult to reverse, widely scaled, weakly monitored, or capable of imposing concentrated harms on subjects with little ability to contest them. A lower threshold can be defensible for bounded, reversible, closely monitored trials when delay itself is costly. The principle is proportionality rather than one fixed standard of evidence.

Definition 25.472 (Uncertainty-bearing arrangement). An *uncertainty-bearing arrangement* identifies which actors or groups bear the material, legal, financial, ecological, relational, or capability consequences if the assumptions supporting an intervention prove mistaken.

This arrangement matters because uncertainty is rarely distributed evenly. An in-

stitution can make a decision while households, workers, communities, future users, or ecosystems absorb most of the downside. Practical attention should therefore examine not only how uncertain a decision is, but who bears the uncertainty.

Proposition 25.473 (Incomplete-knowledge action principle). *When practical action cannot reasonably wait for complete evidence, a GRE-consistent intervention should make its principal uncertainties and error-bearing arrangements explicit, proportion the scale and reversibility of action to the quality of available warrant, and specify conditions for revision as new evidence emerges.*

This principle permits decisive action. Its purpose is to prevent decisiveness from being confused with epistemic certainty. It also guards against the opposite error in which uncertainty is used to avoid action even though inaction has foreseeable consequences and is itself a choice within the relational field.

25.17.2 Relational Consequences

An intervention can achieve its immediate target while altering relationships that matter for later coordination, dependence, trust, legitimacy, access, care, learning, and institutional capacity. GRE therefore asks practitioners to attend to the relational field changed by action, not only to the focal output. A subsidy can change bargaining relations; an automated decision system can reconfigure authority and appeal; a performance metric can alter cooperation; a procurement rule can restructure supply dependence; a benefit programme can change the relation between citizens and administrative institutions.

Definition 25.474 (Practical relational consequence). *A practical relational consequence is a change produced or materially influenced by an intervention in the structure, quality, accessibility, reciprocity, dependence, authority, trust, coordination, or persistence of a relation relevant to later economic or institutional activity.*

Relational consequences may be intended or unintended, beneficial or harmful, temporary or persistent. Their significance depends on the question and affected subjects rather than on a presumption that more relation is always better.

Definition 25.475 (Relational consequence field). *A relational consequence field records the principal relations directly and indirectly altered by an intervention, the mechanism of alteration, the affected subjects, expected direction and duration of change, uncertainty, and the downstream capacities or constraints associated with those relational changes.*

The field expands practical analysis beyond the immediate transaction without requiring unlimited tracing. The relevant boundary is set by material consequence. If an intervention's success depends on trust, cooperation, administrative legitimacy, supplier diversity, knowledge sharing, or ecological stewardship, changes in those relations belong within the practical evaluation.

Definition 25.476 (Relational burden transmission). *Relational burden transmission occurs when an intervention reduces a burden or risk at one location partly by shifting dependence, monitoring, coordination cost, insecurity, or exposure to another relation or group.*

Burden transmission can be justified, unavoidable, or harmful depending on context. The analytical requirement is to make the transfer visible. A reduction in organizational risk can increase worker precarity; a simplified administrative process can

transfer documentation burden to applicants; a resilient supply strategy can transfer ecological or labor pressure to another region.

Definition 25.477 (Relational capacity effect). A *relational capacity effect* is the change in later collective or individual capability generated by an intervention through its alteration of coordination, trust, access, shared knowledge, institutional reliability, or other relation-mediated capacities.

This concept links immediate intervention to later generativity. Some actions create durable relational capacities even when their short-run output is modest; others produce strong immediate output while eroding the relations required for maintenance or adaptation.

Proposition 25.478 (Relational-consequence attention principle). *When an intervention materially changes relations on which later coordination, access, legitimacy, dependence, or generative capacity relies, evaluation should include those relational consequences rather than treating the intervention's immediate output as a sufficient account of its practical effect.*

Relational attention does not make every indirect consequence attributable to the practitioner. It asks for a defensible boundary around reasonably foreseeable and materially relevant relational effects, together with explicit uncertainty where causal responsibility is difficult to establish.

25.17.3 Long-Horizon Effects

Economic and institutional actions often have temporal profiles that differ sharply from their immediate effects. Infrastructure can persist for decades; education and capability formation can yield delayed returns; environmental degradation can accumulate invisibly; debt structures can shift burdens across cohorts; standards can become path dependent; trust can erode slowly and recover slowly. GRE asks practitioners to distinguish immediate performance from the longer horizon over which an intervention alters capacities, dependencies, options, and regenerative conditions.

Definition 25.479 (Practical horizon portfolio). A *practical horizon portfolio* records the time horizons relevant to an intervention, the effects expected to appear within each horizon, the subjects affected, the confidence of those expectations, and the monitoring or review mechanisms appropriate to effects that emerge at different speeds.

The portfolio avoids selecting one universal long term. Different effects mature on different temporal scales. A policy may require daily operational monitoring, annual distributional review, decadal infrastructure assessment, and still longer ecological or intergenerational attention.

Definition 25.480 (Delayed relational effect). A *delayed relational effect* is a material change in a relation, capacity, dependence, institution, or possibility structure that becomes observable only after a time lag following the intervention that contributed to it.

Delayed effects complicate evaluation because short-run indicators can systematically misrepresent the direction of the longer process. An intervention that initially increases cost can build capacity; another that initially lowers cost can produce later dependence or maintenance deficits.

Definition 25.481 (Temporal burden displacement). *Temporal burden displacement* occurs when an intervention secures present benefits or reduces present costs partly

by transferring material, ecological, fiscal, institutional, or capability burdens into later periods or onto later participants.

The category is descriptive rather than automatically condemnatory. Borrowing can rationally transfer costs to future beneficiaries; infrastructure can require future maintenance. The practical issue is whether later burdens are recognized, proportionate, resourced, and borne by subjects with meaningful standing in the decision architecture.

Definition 25.482 (Path-dependent commitment). A *path-dependent commitment* is an intervention-induced change that raises the cost of moving to relevant alternative arrangements because complementary infrastructure, skills, expectations, contracts, institutions, or dependencies accumulate around the chosen path.

Path dependence does not imply irreversibility. It indicates that future comparison must include the endogenous change in switching costs produced by the current decision.

Proposition 25.483 (Multi-horizon evaluation principle). *When an intervention plausibly produces delayed, cumulative, path-dependent, regenerative, or intergenerational effects, practical evaluation should use more than the immediate performance horizon and should state which later effects remain unmeasured or uncertain.*

This principle is compatible with emergency action. A practitioner may need to privilege an immediate horizon when severe near-term harm dominates. The requirement is not equal weighting of all futures, but an explicit account of which horizons are being prioritized and what longer consequences remain attached to that prioritization.

25.17.4 Reversibility

Reversibility matters because action under uncertainty becomes less hazardous when mistakes can be detected and corrected without disproportionate loss. Yet practical reversibility is often overstated. A policy can be formally repealed while reputational damage, capability loss, ecological change, sunk infrastructure, contractual dependence, or institutional distrust remains. GRE therefore asks practitioners to distinguish stopping an action from restoring the relational and material conditions that existed before it.

Definition 25.484 (Practical reversibility profile). A *practical reversibility profile* records, for a proposed intervention, the feasibility and cost of stopping, rolling back, repairing, compensating, redesigning, or exiting the intervention across the material, legal, institutional, relational, ecological, and capability dimensions relevant to the case.

Reversibility is multidimensional. A software deployment can be technically reversible but institutionally sticky; a land-use decision can be legally reversible but ecologically costly; an organizational restructuring can be contractually reversible while lost tacit knowledge is not readily restored.

Definition 25.485 (Recovery distance). A *recovery distance* is the practical difference between terminating an intervention and restoring, replacing, or adequately compensating for the relations, capacities, resources, and possibilities materially altered by that intervention.

A large recovery distance identifies situations in which simple repeal is a weak

proxy for reversibility. The concept does not require literal return to an earlier state, which may be impossible or undesirable. It requires attention to what must be rebuilt or substituted for affected subjects to recover meaningful capacities and options.

Definition 25.486 (Reversibility asymmetry). A *reversibility asymmetry* exists when the actor authorized to initiate or terminate an intervention can reverse its own commitment more easily than affected subjects can reverse the consequences imposed on their relations, capabilities, assets, or environments.

This asymmetry is common in interventions where organizations can exit markets, terminate projects, or change rules while communities, workers, users, or ecosystems retain long-lived consequences. It should therefore enter practical assessment separately from the initiating actor's own exit cost.

Definition 25.487 (Experimentability envelope). An *experimentability envelope* is the bounded region of scale, duration, population exposure, monitoring capacity, and reversibility within which an intervention can reasonably be treated as a learning-oriented trial rather than as a de facto irreversible commitment.

The envelope narrows as possible harm, persistence, or power asymmetry increases. Calling an intervention a pilot does not make it experimental in the epistemically responsible sense if affected subjects cannot exit, adverse consequences cannot be repaired, or monitoring cannot detect relevant failure.

Proposition 25.488 (Irreversibility-sensitive action principle). *As the expected recovery distance, persistence of consequences, or reversibility asymmetry of an intervention increases, practical justification should require correspondingly stronger warrant, narrower initial exposure where feasible, clearer safeguards, and more explicit responsibility for repair or compensation.*

This principle links reversibility to incomplete knowledge without assuming that irreversible action is impermissible. Many necessary actions are irreversible. The practical demand is that irreversibility be treated as part of the stakes rather than hidden behind formal authority to change course later.

25.17.5 Participation

Participation matters because practical interventions are rarely enacted upon a homogeneous public. Different subjects possess different information, dependencies, vulnerabilities, capabilities, and values. They also occupy different positions in implementation. GRE therefore asks practitioners to distinguish nominal inclusion from participation that can materially shape problem definition, design, implementation, monitoring, contestation, and revision.

Definition 25.489 (Practical participation architecture). A *practical participation architecture* records which subjects can enter a decision process, what information and resources they possess, which stages they can influence, how disagreement is registered, what authority attaches to their participation, and what routes exist for contesting or revising the resulting action.

The architecture can include representative institutions, consultation, co-design, bargaining, community governance, worker participation, user testing, expert review, legal standing, complaint mechanisms, or other domain-appropriate forms. GRE does not prescribe one participation format for every case.

Definition 25.490 (Consequential participation). *Consequential participation* is par-

ticipation capable of materially affecting at least one relevant component of problem framing, option generation, decision criteria, implementation, monitoring, remedy, or revision rather than merely recording presence or opinion.

This definition does not imply that every participant should possess veto authority. It distinguishes participation that can enter the generative structure of action from participation whose output is institutionally irrelevant by design.

Definition 25.491 (Participation burden). A *participation burden* is the time, knowledge, documentation, language, financial cost, psychological exposure, technological access, organizational capacity, or risk of retaliation required for a subject to exercise the participation formally offered by an intervention.

Participation can therefore be formally open but practically inaccessible. The burden can also be distributed asymmetrically, allowing organized or well-resourced actors to dominate processes that appear procedurally equal.

Definition 25.492 (Implementation knowledge interface). An *implementation knowledge interface* is a structured channel through which the situated knowledge of affected subjects, frontline implementers, users, or local institutions can alter the design, operation, or revision of an intervention.

The interface gives practical significance to knowledge that may not be available in centralized models. Situated knowledge is not automatically correct, and expert evidence is not automatically superior. The purpose of the interface is to preserve epistemically relevant plurality where implementation outcomes depend on locally distributed information.

Proposition 25.493 (Participation adequacy principle). *When affected subjects possess materially relevant knowledge, bear substantial consequences, or face limited exit from an intervention, practical design should evaluate whether their participation is consequential and accessible rather than inferring adequate participation from formal invitation alone.*

Participation also interacts with reversibility. Subjects who cannot influence initial design may still require strong routes for later complaint, appeal, repair, or exit. A practice can therefore improve participation by widening revision authority even when real-time co-decision is infeasible.

25.17.6 Value Conflict

Practical action frequently requires choices among heterogeneous values that cannot be reduced to one metric without remainder. Cost, safety, autonomy, equality, ecological integrity, cultural continuity, capability, care, privacy, knowledge, speed, resilience, and other values can point in different directions. GRE asks practitioners to make these conflicts visible, identify who bears gains and losses, and distinguish a decision rule from a claim that the underlying values have become equivalent.

Definition 25.494 (Practical value-conflict register). A *practical value-conflict register* identifies the materially relevant value forms affected by an intervention, the subjects or institutions for whom they matter, the direction and expected magnitude or significance of change where assessable, the relations of comparability or incommensurability among them, and the rule or institution through which conflict is being addressed.

The register can coexist with cost-benefit analysis, multi-criteria evaluation, legal

proportionality, democratic deliberation, professional ethics, or other decision practices. Its purpose is to preserve the distinction between making a decision and demonstrating that every affected value has been represented without loss.

Definition 25.495 (Practical commensuration rule). A *practical commensuration rule* is the explicit or implicit procedure through which heterogeneous values are converted, weighted, ranked, thresholded, or otherwise made jointly actionable for the purpose of a decision.

A rule can be technically useful while remaining normatively contestable. Discount rates, quality-adjusted measures, scoring systems, budget constraints, safety thresholds, and legal priority rules each embed judgments about what can be compared and whose losses can be offset by which gains.

Definition 25.496 (Non-compensated value remainder). A *non-compensated value remainder* is a materially relevant loss, claim, obligation, or value dimension that remains after the practical decision rule has selected an action and that is not represented as fully offset by gains recognized elsewhere in the decision process.

Preserving remainder does not imply that action should be blocked until every conflict is resolved. It allows the action record to retain obligations for mitigation, compensation, monitoring, reconsideration, or explicit acceptance of unresolved loss.

Definition 25.497 (Value-conflict authority). *Value-conflict authority* identifies the actor, institution, procedure, or legal order authorized to settle a practical conflict among values for the specified decision, together with the scope and contestability of that authority.

This object matters because the existence of a metric does not itself establish authority to impose the metric. Practical reasoning should distinguish technical capacity to calculate from institutional or normative standing to decide.

Proposition 25.498 (Value-conflict disclosure principle). *When an intervention requires trade-offs among materially heterogeneous values, practical justification should disclose the governing commensuration or priority rule, the authority through which it is applied, and significant non-compensated remainder rather than representing the selected option as value-neutral.*

The principle leaves substantive value theory open. GRE does not derive one hierarchy of values from generativity itself. It asks that practical conflict remain visible enough for those affected, later reviewers, and future revisions to reconstruct how the settlement was reached.

25.17.7 Power Asymmetry

Practical action occurs within distributions of authority, resources, information, bargaining capacity, infrastructure, exit options, and agenda control that predate the intervention and can be changed by it. GRE therefore asks practitioners to distinguish asymmetry from realized power while examining the mechanisms through which asymmetry shapes choice, participation, implementation, exposure, and revision. Formal consent or market exchange does not settle this question when relevant dependencies structure what parties can realistically refuse.

Definition 25.499 (Action-facing power profile). An *action-facing power profile* records the typed asymmetries relevant to an intervention, the relations through which those asymmetries may become consequential, the actors controlling key

interfaces or sanctions, the distribution of exit and voice capacities, and the expected changes in power produced by the intervention itself.

The profile should remain mechanism-specific. Income difference, legal authority, data access, ownership, expertise, network position, and infrastructural control can each be power-relevant in different ways. No single asymmetry should automatically be treated as a complete measure of power.

Definition 25.500 (Practical dependency leverage). *Practical dependency leverage* exists when an actor can shape another subject's feasible choices or terms of participation because the latter depends materially on a resource, relation, platform, institution, status, infrastructure, or service controlled by the former.

Dependency is not inherently exploitative. Many legitimate institutions organize beneficial dependencies. The practical issue is whether leverage can be exercised without adequate countervailing capacity, appeal, transparency, or exit.

Definition 25.501 (Interface power). *Interface power* is the capacity to set or alter the rules, categories, thresholds, access conditions, conversion terms, procedural steps, or technical standards through which other actors must pass to obtain a resource, right, recognition, service, or opportunity relevant to the intervention.

Interface power can be especially difficult to see because it operates through design rather than direct command. Eligibility rules, algorithmic classifications, procurement standards, application procedures, interoperability choices, and documentation requirements can restructure feasible action without explicit coercion.

Definition 25.502 (Revision-power asymmetry). A *revision-power asymmetry* exists when actors differ materially in their capacity to trigger review, alter implementation, obtain exceptions, demand explanation, secure remedy, or cause an intervention to be reconsidered after it has begun.

Revision power is central to action under uncertainty. A decision can be formally revisable while practically rigid for subjects who lack standing, resources, information, or institutional access to activate the revision process.

Proposition 25.503 (Power-sensitive intervention principle). *When materially relevant asymmetries shape participation, refusal, exposure, implementation, or revision, practical evaluation should examine the mechanisms through which those asymmetries become power and should avoid interpreting formal consent, availability of choice, or procedural equality as sufficient evidence of neutral conditions.*

Attention to power also requires reflexivity. An intervention can create new asymmetries by concentrating data, expertise, infrastructure, authority, or dependency in actors who did not previously possess them. Practical assessment should therefore include the power structure likely to exist after implementation, not only the one that existed before it.

25.17.8 Learning through Action

The preceding dimensions imply that practical action is also an epistemic event. Intervention generates evidence about causal mechanisms, implementation conditions, participant responses, value conflicts, unintended consequences, and the adequacy of the original representation. GRE therefore asks practitioners to design learning into action where feasible. Learning through action is not an excuse to experiment without safeguards. It is a requirement to preserve feedback, detect error, and create

revision pathways when action necessarily proceeds under incomplete knowledge.

Definition 25.504 (Action-generated evidence). *Action-generated evidence* is evidence produced through the implementation, monitoring, contestation, failure, adaptation, or consequence of an intervention and capable of revising the assumptions, models, values, or practical design that initially supported the action.

Such evidence can include quantitative outcomes, administrative records, user behavior, frontline observations, complaints, legal challenges, ecological indicators, implementation failures, unexpected adaptations, or the absence of an effect that had been assumed likely.

Definition 25.505 (Practical learning channel). A *practical learning channel* is a structured pathway through which action-generated evidence can reach actors authorized and capable of interpreting it and changing implementation, safeguards, scale, resource allocation, or the underlying intervention design.

Monitoring without a learning channel can generate information without adaptation. Complaint systems without decision authority can register harm without changing practice. The channel therefore includes both information movement and a relation to revision capacity.

Definition 25.506 (Adaptive intervention). An *adaptive intervention* is an intervention whose implementation architecture specifies review points, observable triggers, permitted modifications, stopping or scaling conditions, and responsibility for acting on new evidence while preserving constraints that protect affected subjects.

Adaptation should not become discretionary instability. Rights, legitimate expectations, legal constraints, safety requirements, and distributional commitments can limit what may be changed. The purpose is disciplined revisability rather than continuous improvisation.

Definition 25.507 (Practical learning debt). *Practical learning debt* is the accumulated difficulty of correcting an intervention created when relevant feedback is not collected, negative results are not preserved, affected subjects lack reporting channels, assumptions are undocumented, or implementation changes occur without provenance.

Learning debt increases the cost of later re-epistemization. It can make persistent failure appear mysterious because the programme no longer knows which assumptions were active, when conditions changed, or which warning signals were previously observed.

Definition 25.508 (Scale-learning relation). A *scale-learning relation* records whether the evidence generated at one intervention scale remains informative when the intervention expands across populations, institutions, jurisdictions, technologies, or ecological conditions with different relational structures.

Success at small scale does not guarantee success after scaling because participation burdens, power effects, coordination requirements, rare harms, infrastructure constraints, and feedback dynamics can change with scale. Conversely, local failure can reveal design defects that are correctable before expansion.

Proposition 25.509 (Action-learning integration principle). *When an intervention proceeds under material uncertainty and can be monitored without violating overriding constraints, practical design should connect implementation to evidence preservation, interpretable feedback, review authority, and explicit revision triggers so that action can improve the warrant of subsequent action rather than merely consume uncertainty.*

Definition 25.510 (Practitioner-attention portfolio). A *GRE practitioner-attention portfolio* is an intervention-level record that connects the practical uncertainty register to relational consequence fields, horizon portfolios, reversibility profiles, participation architectures, value-conflict registers, action-facing power profiles, and practical learning channels, while preserving decisions, revisions, unresolved remainder, and domain-specific constraints.

The portfolio is not a mandatory bureaucratic form. It is a conceptual architecture for maintaining continuity between practical judgment, implementation, monitoring, and revision. In simple settings, the record can be compact. In large public or institutional interventions, its components may be distributed across impact assessment, governance documents, technical monitoring, legal safeguards, participation processes, and evaluation systems.

Proposition 25.511 (Practitioner-attention integration principle). *GRE practice is most consistent with the programme developed in this book when action under incomplete knowledge remains traceable to its expected relational consequences, time horizons, reversibility conditions, participation structure, value conflicts, power asymmetries, and learning pathways, while materially relevant uncertainty and residual disagreement remain explicit and revisable.*

This integration principle closes the practitioner-facing synthesis without reducing practice to optimization or procedural compliance. Practical judgment remains domain-specific and institutionally situated. GRE contributes a discipline of consequential attention: uncertainty should not disappear behind decisiveness, relational change behind output indicators, delayed effects behind short-run success, irreversibility behind formal repeal, participation behind invitation, value conflict behind aggregation, power behind apparent consent, or learning behind implementation. The next section turns from what present researchers and practitioners should keep visible to what the book deliberately leaves unresolved for future work.

25.18 Unresolved Research Agenda in Generative Relational Economics

An open research programme requires more than an admission that further work remains. It requires a disciplined account of which unresolved objects are presently consequential, why their warrant remains incomplete, what kinds of inquiry could advance them, and how future results would revise the programme. The role of this section is therefore to convert selected unresolved problems in Generative Relational Economics (GRE) into a forward research agenda without treating that agenda as exhaustive or as a forecast of the programme's eventual form. The discussion organizes future work around eight research fronts: empirical validation, formal development, value conversion theory, justice under incommensurability, multiscale economic history, AI-era transformation, cross-domain comparison, and the possible maturation of a future general theory. The method is programme-architectural. Each front is specified in terms of its present epistemic status, missing warrant, research tasks, and conditions under which progress would support revision, restriction, branching, or abandonment of current GRE formulations.

Definition 25.512 (Future-work object). A *future-work object* is a question, construct, relation, hypothesis, formalism, empirical claim, normative problem, or domain in-

Table 25.18: Selected unresolved research fronts in GRE and their principal maturation tests

Research front	Principal maturation test	Premature-closure risk
Empirical validation	Domain-specific operationalization, discriminating evidence, replication, and scope estimation	Treating conceptual plausibility as empirical support
Formal development	Typed derivation, interpretability, identifiable assumptions, and evidence linkage	Treating mathematical elaboration as substantive confirmation
Value conversion theory	Mechanism-specific accounts of conversion, remainder, agency, power, and regeneration	Collapsing heterogeneous values into unexamined commensuration
Justice under incommensurability	Defensible procedures and substantive constraints for conflict among partly incomparable values	Equating decision with demonstrated equivalence or full compensation
Multiscale economic history	Reconstructable relations among events, institutions, structures, and heterogeneous timescales	Projecting one scale's categories or mechanisms onto another
AI-era transformation	Versioned evidence on capability, dependence, institutions, labor, value, and governance	Freezing a rapidly changing sociotechnical configuration into a timeless model
Cross-domain comparison	Comparable research designs that preserve domain predicates, counterexamples, and translation remainder	Inferring shared mechanism from shared vocabulary or superficial resemblance
Future general theory	Cross-domain survival of candidate structures under translation, counterexample, and boundary testing	Promoting recurrent analogies into universal architecture before warrant exists

terface whose present treatment is insufficient for a consequential GRE inference and for which the missing warrant can be stated with enough precision to guide further inquiry.

The definition excludes a purely rhetorical statement that “more research is needed.” A future-work object should identify what remains unsettled and what kind of result could alter its status. Some future-work objects require additional data; others require conceptual clarification, formal derivation, historical reconstruction, normative argument, comparative inquiry, or a combination of these modes.

Definition 25.513 (Research maturation path). A *research maturation path* records, for a future-work object, its current epistemic status, principal unresolved dependencies, admissible methods of inquiry, relevant counterevidence, intermediate evidential or theoretical milestones, and the programme changes that would follow from success, persistent ambiguity, or failure.

Maturation need not mean movement toward confirmation. A research front matures when its status becomes better warranted and more discriminating, including when a proposed GRE construct is narrowed, replaced, divided into domain-specific variants, or rejected. Table 25.18 summarizes the eight fronts developed in this section and the principal risk of closing each one too early.

Proposition 25.514 (Future-work selectivity principle). A *GRE future research agenda*

is epistemically useful when it prioritizes unresolved objects whose clarification would materially change the programme's explanatory, empirical, normative, practical, or cross-domain warrant, while preserving the possibility that later evidence will generate research fronts not presently anticipated.

The eight fronts below should therefore be read as high-leverage unresolved areas within the present version of GRE. They organize work made visible by the current book; they do not define the outer boundary of future inquiry.

25.18.1 Empirical Validation

GRE contains constructs that range from interpretive distinctions to candidate empirical mechanisms. Their empirical maturation requires more than attaching measurements to existing terminology. Different GRE claims imply different evidential tasks. A claim about value circulation may require process and network evidence; a claim about historical path dependence may require longitudinal or archival evidence; a claim about power realization may require evidence connecting typed asymmetry to actual transformation capacity; and a claim about generative participation may require observation of whether participation changes later option formation. Empirical validation should therefore begin with the inferential target rather than with a generic demand for quantification.

Definition 25.515 (GRE empirical programme). A *GRE empirical-validation programme* is a coordinated set of studies that connects GRE constructs to observable or reconstructable evidence, specifies rival explanations, estimates scope conditions, preserves negative results, and evaluates whether the evidence supports, revises, localizes, or defeats the target claim.

Such a programme can include experiments, quasi-experiments, observational datasets, field studies, surveys, administrative records, archival reconstruction, ethnography, comparative case analysis, network analysis, process tracing, computational simulation linked to observed data, or mixed-method designs. Method selection follows the target relation and available evidence rather than a hierarchy in which one method automatically validates the framework.

Definition 25.516 (Evidential target map). An *evidential target map* identifies the GRE object being investigated, the observable consequences or historical traces expected under the proposed mechanism, plausible rival accounts, data-generation conditions, relevant units and timescales, and the inference that the evidence could or could not support.

The target map is especially important for broad concepts such as generativity, relational capacity, conversion, circulation, and power. Without a target map, multiple incompatible empirical patterns can be redescribed after the fact as evidence for the same concept.

Definition 25.517 (Operationalization bridge). An *operationalization bridge* is an explicit justification connecting a theoretical GRE construct to one or more indicators, observations, classifications, or reconstructed events while recording what dimensions of the construct remain unrepresented by those empirical proxies.

An operationalization can be useful without exhausting the construct. For example, a network measure can represent one aspect of relational position while omitting meaning, institutional authority, historical provenance, or latent capability. The

bridge should preserve that remainder instead of treating a measurable component as the whole theoretical object.

Definition 25.518 (Empirical scope envelope). An *empirical scope envelope* records the populations, institutions, periods, jurisdictions, technological conditions, relational configurations, and measurement regimes within which an empirical result has been established with the warrant presently available.

Scope envelopes allow GRE to accumulate empirical support without converting a local regularity into a universal proposition. Replication and comparative work can later widen, divide, or contract an envelope.

Proposition 25.519 (Empirical maturation principle). A GRE construct gains empirical maturity when multiple research designs can discriminate the target relation from plausible alternatives, when operationalization remainder and scope conditions remain explicit, and when negative or contradictory results can revise the construct rather than being absorbed through unrestricted reinterpretation.

A major future task is therefore to build cumulative evidence around selected constructs instead of attempting simultaneous empirical confirmation of GRE as a whole. The programme can become more empirically discriminating even if different components receive different outcomes: some may stabilize, some may remain heuristic, and others may be retired.

25.18.2 Formal Development

Formal development is a second major research front because the present book uses formal objects selectively and at several levels of abstraction. Some formalisms clarify conceptual relations; some propose dynamical representations; some indicate possible algebraic, geometric, network, or operator-based structures; and some remain programmatic. Future formal work should increase discriminating power, derivational transparency, and empirical or interpretive connection rather than simply increase symbolic density.

Definition 25.520 (Formal-development path). A *formal-development path* is a staged programme through which a GRE formal representation is given explicit primitive objects, typing rules, assumptions, derivations, admissible operations, interpretive mappings, empirical or historical interfaces, and criteria for comparison with alternative formalisms.

The path can terminate at different levels. A structural formalization may remain valuable without becoming an estimable model. A computational model may support counterfactual exploration without establishing ontology. An empirically parameterized model may be useful in one domain without becoming the canonical formal language of GRE.

Definition 25.521 (Formal adequacy profile). A *formal adequacy profile* records whether a GRE formalism possesses type consistency, derivational completeness for the claims it makes, interpretable primitives, explicit assumptions, identifiable scope, tractable or characterizable dynamics where relevant, and a stated relation to evidence or interpretation.

These dimensions prevent a formal object from gaining authority merely because it is mathematically sophisticated. A formalism can be internally elegant yet poorly connected to the economic phenomenon it is intended to represent. Conversely, a

deliberately simple formalism can be adequate if it isolates a mechanism and exposes testable consequences.

Definition 25.522 (Formalism comparison dossier). A *formalism comparison dossier* is a record comparing two or more candidate representations with respect to their primitives, preserved distinctions, assumptions, expressive capacity, inferential outputs, empirical interfaces, computational demands, and known failure cases.

GRE's commitment to plural formulations makes such comparison preferable to premature canonization. Network, dynamical-system, category-theoretic, field-theoretic, agent-based, game-theoretic, operator-algebraic, and other representations can illuminate different questions. Their coexistence becomes productive when the programme can state which relations each representation preserves and where translation among them fails.

Definition 25.523 (Formal-to-evidential interface). A *formal-to-evidential interface* specifies how formal states, parameters, operators, relations, or invariants correspond to observable, reconstructable, or interpretively warranted features of an economic case, including uncertainty and non-identifiability in that correspondence.

The interface is particularly important for highly abstract representations. Without it, a model can organize thought while remaining insulated from empirical correction. That status can be legitimate when explicitly stated; the problem arises when heuristic or representational usefulness is silently converted into empirical confirmation.

Proposition 25.524 (Formal maturation principle). *Future GRE formalization is most informative when increasing mathematical structure also increases at least one of the following: conceptual precision, derivational constraint, discriminability among mechanisms, empirical testability, computational exploration, or transparent comparison with alternative representations.*

Formal development therefore remains open at both foundational and domain-specific levels. Some future work may simplify existing constructions; some may derive previously introduced objects from more primitive ones; some may prove incompatibility among formulations; and some may reveal that an apparently general structure is only locally adequate.

25.18.3 Value Conversion Theory

Value conversion remains one of the most consequential unresolved GRE research fronts. The book distinguishes generation, transfer, conversion, circulation, realization, capture, dissipation, return, recirculation, and regeneration, yet a general theory of how heterogeneous value forms become convertible, partially convertible, or non-convertible remains preliminary. Future work should investigate conversion as a relational and institutional process rather than assuming that observed prices, scores, rankings, or exchange ratios transparently reveal equivalence among values.

Definition 25.525 (Value-conversion research object). A *value-conversion research object* is a historically and institutionally situated process in which one recognized value form is translated, exchanged, represented, transformed, or made actionable in terms of another value form through a conversion interface with identifiable rules, actors, authority, frictions, and remainder.

This object can include monetary pricing, credential conversion, reputation

metrics, legal compensation, ecological valuation, labor evaluation, algorithmic scoring, social recognition, or other mechanisms through which heterogeneous values acquire actionable relations. The relevant research question concerns how the conversion becomes possible, who controls its terms, what is preserved, what is altered, and what remains outside the conversion.

Definition 25.526 (Conversion mechanism profile). A *conversion mechanism profile* records the source and destination value forms, the conversion interface, rule-setting authority, participating and excluded subjects, information requirements, temporal structure, conversion costs, uncertainty, reversibility, and residual value that the conversion does not represent.

The profile creates a common research architecture without presuming that different conversions share one mechanism. Market exchange, administrative scoring, legal damages, educational credentials, and cultural recognition can all involve conversion while remaining institutionally and normatively distinct.

Definition 25.527 (Conversion remainder). A *conversion remainder* is the dimension of a source value relation that is not preserved in the destination representation or actionable value form under the conversion rules used in a specific case.

Remainder can be epistemic, normative, relational, temporal, or distributional. A monetary compensation can leave relational loss unresolved; an index can omit local meaning; a credential can compress heterogeneous capability; an algorithmic score can reduce context into a standardized ranking. Remainder is therefore an object of inquiry rather than merely measurement error.

Definition 25.528 (Conversion-power relation). A *conversion-power relation* is a relation in which an actor or institution possesses materially consequential capacity to set, modify, enforce, contest, or selectively access the rules through which one value form is converted into another.

This capacity can shape which values become legible and which losses are recognized. Future value-conversion theory should therefore connect conversion with power, participation, institutional design, and justice rather than studying ratios or equivalences in isolation.

Definition 25.529 (Conversion-chain study). A *conversion-chain study* reconstructs a sequence in which value passes through multiple representations or interfaces and evaluates how value form, agency, distribution, meaning, uncertainty, and remainder change at each conversion stage.

Many economic processes contain chained conversion: knowledge can become a credential, the credential can influence employment, employment can generate income and status, and those outputs can alter future educational access. Studying a single interface may therefore miss cumulative loss, amplification, capture, or regeneration across the chain.

Proposition 25.530 (Value-conversion maturation principle). A *mature GRE theory of value conversion* should explain the conditions under which conversion occurs, preserve distinctions among conversion and adjacent value processes, identify institutional and power-mediated mechanisms, represent conversion remainder, and permit empirical comparison across cases without presuming universal commensurability.

This research front is likely to require sustained collaboration among economic theory, institutional analysis, history, law, sociology, anthropology, ecology, and measurement studies. Cross-domain contribution should preserve the predicates of those

domains rather than converting the entire problem into an economic metric.

25.18.4 Justice under Incommensurability

GRE's recognition of heterogeneous value creates a corresponding normative problem. Decisions still have to be made when relevant values are only partly comparable, when compensation is incomplete, or when one affected subject does not accept the conversion rule used by another institution. Future work on justice therefore concerns both substantive distribution and the legitimacy of the procedures through which partially incommensurable claims are represented, negotiated, protected, or left unresolved.

Definition 25.531 (Value-plural justice problem). An *incommensurability-sensitive justice problem* is a distributive, procedural, corrective, recognitional, or intergenerational problem in which materially relevant claims are expressed through value forms that cannot be fully reduced to a common measure without normative or informational remainder.

The definition does not imply absolute incomparability. Values may be comparable in some respects, rankable under specific thresholds, or actionable through institutions despite lacking a complete common metric. The theoretical task is to represent the remaining plurality rather than infer equivalence from the fact that a decision was reached.

Definition 25.532 (Justice remainder). A *justice remainder* is a materially relevant claim, loss, obligation, status, capability, relation, or value that remains insufficiently addressed after a practical allocation, compensation, balancing procedure, or institutional settlement has been completed.

A remainder can persist even when a decision is lawful, efficient, or procedurally valid. Recording it does not by itself establish that the decision was unjust. It preserves an object for later evaluation, remedy, reinterpretation, or institutional learning.

Definition 25.533 (Commensuration authority profile). A *commensuration authority profile* identifies the actors and institutions authorized to determine which values are compared, which metrics or thresholds are used, whose testimony or evidence is admissible, how disagreement is treated, and what routes exist for appeal, revision, or refusal.

This profile connects justice to power. A conversion rule can be procedurally transparent while the authority to define relevant values remains highly concentrated. Future work should therefore study the justice of commensuration institutions alongside the outputs they generate.

Definition 25.534 (Non-compensation constraint). A *non-compensation constraint* is a normative or institutional rule specifying that improvement in one value dimension cannot, within the relevant decision context, fully offset loss beyond a stated threshold in another dimension.

Rights, safety floors, ecological limits, anti-discrimination protections, or minimum capability requirements can function in this way. Such constraints provide one family of responses to incommensurability without requiring a complete cardinal ordering of all values.

Definition 25.535 (Plural-justice comparison). A *plural-justice comparison* evaluates

an economic arrangement through multiple explicitly distinguished justice lenses and records agreements, conflicts, domain dependencies, and unresolved remainder among the resulting judgments.

Future GRE work need not synthesize every justice theory into one meta-theory. Comparison can instead reveal which conclusions depend on particular normative commitments and where distinct theories converge on practical constraints despite different foundations.

Proposition 25.536 (Justice maturation principle). *GRE's future normative development is strengthened when decisions among heterogeneous values remain traceable to their commensuration rules, authority structures, non-compensation constraints, affected subjects, and unresolved justice remainder; while rival normative interpretations remain available for contestation where the underlying theory does not uniquely determine a settlement.*

Justice under incommensurability is therefore not a residual issue to be solved after positive economics. It is partly constitutive of how conversion, allocation, power, participation, and future option structures become institutionally organized.

25.18.5 Multiscale Economic History

GRE treats economic relations as historically formed and often distributed across heterogeneous timescales. Future work should develop this historical dimension more systematically. The challenge is to connect events, actor trajectories, institutional sequences, infrastructural change, long-run structural transformation, and inherited relational conditions without reducing one scale to another or assuming that mechanisms remain stable across periods.

Definition 25.537 (Multiscale economic-history programme). *A multiscale economic-history programme* is a research programme that reconstructs economically relevant relations across two or more temporal, spatial, institutional, or organizational scales and investigates how processes at those scales condition, amplify, constrain, or transform one another.

The relevant scales depend on the question. They can include transactions, projects, organizations, careers, generations, policy regimes, technological systems, states, international orders, or longer ecological and infrastructural trajectories.

Definition 25.538 (Historical scale profile). *A historical scale profile* records the temporal and organizational resolutions at which a historical claim is formulated, the evidence available at each resolution, and the mechanisms proposed to connect changes across scales.

This profile helps distinguish a genuine multiscale explanation from a narrative that merely juxtaposes short-run events and long-run trends. The connection mechanism can involve institutional inheritance, learning, capital accumulation, technological lock-in, demographic change, legal continuity, ecological feedback, or other historically warranted processes.

Definition 25.539 (Scale-translation record). *A scale-translation record* specifies which categories, actors, relations, and causal claims remain meaningful when analysis moves between historical scales, which require reinterpretation, and which fail to transfer.

An individual transaction cannot automatically be treated as a miniature institu-

tional order, and a century-scale structural tendency cannot automatically explain a local event. Scale translation requires an explicit account of aggregation, mediation, selection, and historical transformation.

Definition 25.540 (Historical mechanism drift). *Historical mechanism drift* is a change through time in the operation, strength, meaning, institutional embedding, or boundary conditions of a mechanism that retains a similar analytical label.

Drift matters because terms such as market, labor, capital, household, education, information, platform, or state can refer to institutionally different relations across periods. A model can appear historically stable while the mechanism represented by its variables has changed.

Definition 25.541 (Event-structure coupling study). An *event-structure coupling study* investigates how historically situated events modify relatively persistent relational structures and how those structures condition the probability, interpretation, or consequence of later events.

This research object offers one route for connecting event history with GRE's generative-spacetime vocabulary without requiring a single universal formalism. Historical evidence can determine whether a proposed coupling is credible in a particular domain.

Proposition 25.542 (Multiscale historical maturation principle). *GRE's historical claims become more robust when scale selection, category continuity, mechanism drift, evidential resolution, and cross-scale coupling are made explicit enough that alternative periodizations or historical interpretations can alter the resulting explanation.*

A mature multiscale programme would also improve empirical validation elsewhere in GRE. It can reveal when apparently contradictory studies examine different historical regimes, when causal effects depend on inherited structures, and when present categories are poor representations of earlier economic worlds.

25.18.6 AI-Era Transformation

Artificial intelligence is a continuing research front because AI-mediated economic relations are changing more rapidly than a static theoretical description can reliably capture. GRE has developed concepts for epistemic economy, capability asymmetry, dependence, value generation, institutional mediation, and domain implications, yet the empirical form and social significance of these relations remain historically contingent. Future work should therefore study AI-era transformation through versioned, revisable observations rather than project one technological moment indefinitely into the future.

Definition 25.543 (AI-era transformation programme). An *AI-era transformation programme* is a versioned research programme that tracks how changing AI capabilities, deployment architectures, ownership structures, institutional rules, labor processes, epistemic practices, and public responses alter economic relations, generative capacities, dependencies, and distributions over time.

The programme should distinguish technical capability change from adoption, organizational integration, legal authorization, cultural acceptance, and economic realization. A capability can exist without transforming a domain, while modest technical change can produce large economic effects when institutions reorganize around it.

Definition 25.544 (Capability redistribution record). A *capability redistribution*

record traces how an AI-mediated change expands, substitutes, complements, concentrates, degrades, or renders dependent the capabilities of different subjects, organizations, professions, communities, and public institutions.

Such records can distinguish aggregate productivity change from the distribution of practical agency. The same system can lower the cost of one task while concentrating model access, evaluation authority, infrastructure ownership, or epistemic dependence elsewhere.

Definition 25.545 (AI institutionalization pathway). An *AI institutionalization pathway* records how an AI capability becomes embedded in rules, workflows, standards, professional expectations, markets, education, public administration, or infrastructure and how that embedding changes the cost and feasibility of later exit or revision.

Institutionalization creates path dependence. Once assessment, hiring, research, public services, or communication infrastructures are reorganized around AI-mediated processes, the relevant economic object is no longer the model alone but the coupled sociotechnical arrangement.

Definition 25.546 (AI version horizon). An *AI version horizon* is the period and technological-institutional configuration for which an empirical or theoretical claim about AI-mediated economic relations remains sufficiently specified to be evaluated without assuming that later systems preserve the same capabilities, interfaces, costs, or governance conditions.

Version horizons should become standard in fast-changing AI research. They permit strong local claims while making temporal expiry visible. Later re-epistemization can then determine which findings persist across technological generations.

Definition 25.547 (AI reflexive transformation). *AI reflexive transformation* is a process in which representations, predictions, classifications, or recommendations produced by AI systems alter the behavior, institutions, data-generating processes, or categories that future AI systems subsequently observe and model.

Reflexivity can change both the economic field and the evidence used to describe it. Future work should investigate these feedbacks in domains where AI-mediated classifications influence access, reputation, prices, labor allocation, knowledge production, or policy.

Proposition 25.548 (AI-era maturation principle). *GRE research on AI becomes more durable when claims are versioned by technological and institutional conditions, capability change is separated from realized economic transformation, distributional and dependency effects are traced alongside aggregate gains, and reflexive feedback is treated as a possible source of mechanism change rather than as residual noise.*

This agenda should remain empirically responsive. AI may generate transformations that the current GRE vocabulary does not anticipate. Those cases should be allowed to revise the framework rather than being redescribed until they fit existing categories.

25.18.7 Cross-Domain Comparison

The book has established interfaces with history, governance, law, education, ecology, artificial-intelligence studies, political theory, social theory, aesthetics, and other neighboring domains. The next research step is comparative rather than merely translational. Future work should test whether candidate relational or

generative structures recur across domains under sufficiently different conditions, where their mechanisms diverge, and which apparent similarities disappear when domain-specific predicates are restored.

Definition 25.549 (Cross-domain comparative programme). A *cross-domain comparative programme* is a coordinated inquiry in which two or more domains investigate a shared question or candidate structure using domain-appropriate evidence and concepts while preserving a common record of correspondences, divergences, counterexamples, translation operations, and non-transferable remainder.

This programme differs from applying one GRE model everywhere. Its value lies partly in discovering failed transfer. A structure that appears general in economics may depend on institutional predicates absent in law or ecology; a mechanism identified in governance may require agency conditions unavailable in another domain.

Definition 25.550 (Comparative invariance candidate). A *comparative invariance candidate* is a relation, constraint, transformation pattern, or structural property that appears to persist across multiple domain-specific representations after relevant vocabulary, scale, agency, and evidential differences have been explicitly considered.

The term *candidate* is essential. Recurrent language alone does not establish invariance. Comparative studies should test whether the relation survives alternative operationalizations and whether domain experts agree that the translated structure retains its relevant meaning.

Definition 25.551 (Negative-transfer result). A *negative-transfer result* is a documented case in which a GRE construct, mechanism, formalism, or normative inference that is useful in one domain fails, distorts the target object, or loses essential predicates when transferred to another domain.

Negative transfer is a substantive result. It can identify domain boundaries, improve translation rules, or show that a proposed general structure should remain domain-specific. Preserving such results is necessary if cross-domain research is to constrain generalization rather than merely supply analogies.

Definition 25.552 (Comparative depth ladder). A *comparative depth ladder* distinguishes progressively stronger cross-domain findings, including shared question, terminological correspondence, structural correspondence, mechanism correspondence, recurrent constraint, and candidate invariance, with each level requiring additional warrant beyond the preceding one.

The ladder prevents movement from a common question directly to a general theory. Two domains can share a question without sharing mechanisms. They can share a structural pattern generated through different mechanisms. Even mechanism correspondence can remain limited by domain-specific boundary conditions.

Definition 25.553 (Cross-domain correction loop). A *cross-domain correction loop* is a process through which a translated GRE object is tested in another domain, the receiving domain identifies fit, remainder, or failure, and those results return to revise the source-domain formulation or its claimed scope.

The correction loop makes cross-domain work bidirectional. Neighboring fields are not merely sources of examples or applications; they can expose hidden assumptions in GRE and force economic concepts to become narrower or more precise.

Proposition 25.554 (Cross-domain maturation principle). *Cross-domain learning supports stronger generalization only when comparative findings survive domain-*

appropriate evidence, preserve relevant semantic and institutional predicates, incorporate negative-transfer results, and remain open to source-framework revision through correction loops.

This research front can therefore advance GRE even when it produces less generality. More accurate boundaries, differentiated mechanisms, and explicit non-translation can constitute theoretical progress within an open programme.

25.18.8 Future General Theory

The possibility of a future Generative Relational Theory (GRT) remains the most ambitious research front and the one requiring the greatest restraint. GRE is currently an economic-domain development informed by preliminary GR foundations. Repeated structures across economics and neighboring domains may eventually support a more general theoretical architecture, yet the existence, scope, and form of such a theory cannot be inferred from the present book alone. Future generalization should be treated as a promotion problem: candidate structures acquire broader status only after surviving demanding cross-domain and epistemic tests.

Definition 25.555 (General-theory candidate). A *general-theory candidate* is a relation, primitive, transformation rule, constraint, equivalence structure, generative mechanism, or formal architecture proposed to possess explanatory or representational relevance across multiple domains beyond its original GRE context.

A candidate can arise from recurrent empirical findings, formal reconstruction, comparative history, philosophical analysis, or successful cross-domain translation. Its origin does not determine its eventual status.

Definition 25.556 (Generalization promotion dossier). A *generalization promotion dossier* records the domains in which a general-theory candidate has been studied, the domain-specific formulations used, positive and negative evidence, translation remainder, counterexamples, alternative explanations, formal representations, normative dependencies, and the scope proposed for any broader claim.

The dossier makes generalization cumulative and contestable. It also allows a candidate to remain useful at an intermediate level without forcing a binary choice between domain specificity and universal theory.

Definition 25.557 (Domain-survival test). A *domain-survival test* evaluates whether a general-theory candidate retains a stable and non-trivial analytical role across multiple domains after domain-specific predicates, scales, agency conditions, evidential practices, and counterexamples are restored.

Survival does not require identical manifestation. A genuinely general relation may appear differently across domains. The requirement is that the proposed abstraction preserve enough structure to constrain inquiry rather than become so permissive that every outcome can be redescribed as compatible with it.

Definition 25.558 (Generality threshold). A *generality threshold* is a stated evidential and theoretical standard that a candidate must satisfy before its status is widened from a domain-specific or cross-domain hypothesis to a more general component of GR or a future GRT.

Different candidates can require different thresholds. A formal identity, a historical mechanism, a normative principle, and a relational ontology claim should not be promoted through the same evidence. The threshold must match the epistemic type

of the candidate.

Definition 25.559 (General-theory remainder). A *general-theory remainder* is the set of domain-specific meanings, mechanisms, evidential conditions, normative predicates, or historical features that remain necessary for explanation after a candidate general structure has been abstracted.

Remainder protects a future general theory from becoming explanatorily imperial. A general relation can organize comparison while domain theories retain indispensable explanatory work.

Proposition 25.560 (General-theory promotion principle). A *candidate should acquire broader GR or GRT status only to the extent that its promotion dossier demonstrates cross-domain survival, discriminating content, reconstructable translation, resilience to relevant counterexamples, and an explicit account of the domain-specific remainder that the general structure does not explain.*

Proposition 25.561 (General-theory deferral principle). *When available cross-domain evidence supports shared questions or partial structural correspondence but remains insufficient for a stable general mechanism or architecture, maintaining the candidate at an intermediate or domain-specific status is a positive theoretical result rather than a programme failure.*

Future GRT work may therefore emerge through a long sequence of comparisons, failed translations, revised primitives, competing formalisms, and domain corrections. GRE can contribute to that process while retaining economic specificity. The possibility of a broader theory does not reduce the value of domain-level explanation.

Definition 25.562 (GRE open-work portfolio). A *GRE open-work portfolio* is a versioned programme record connecting future-work objects to their research maturation paths, responsible or relevant research communities, evidential and theoretical dependencies, negative results, intermediate outputs, unresolved remainder, and consequences for GRE if the target object is supported, revised, localized, divided, or abandoned.

The portfolio provides continuity between the present book and later versions of the programme. It can also prevent future work from being judged only by whether it confirms current formulations. A failed empirical hypothesis, a superior alternative formalism, a historically bounded mechanism, a non-convertible value relation, or a negative cross-domain transfer can each improve the programme by reducing unwarranted generality.

Proposition 25.563 (Open-work integration principle). *GRE remains an open research programme when consequential unresolved objects are preserved as explicit research obligations with identifiable maturation paths, while future investigators retain authority to generate new questions, alter the agenda, and revise the framework in response to evidence, argument, historical change, and domain-specific correction.*

The unresolved agenda therefore provides a bridge to provisional closure rather than a substitute for closure. Empirical validation, formal development, value conversion, justice under incommensurability, multiscale history, AI-era transformation, cross-domain comparison, and possible general-theory formation identify major continuations of the present work. Their unresolved status is part of the programme's epistemic architecture. The final section can consequently close the book at the level of a versioned framework while leaving its research objects, counterexamples, collaborations, and possible successors open to continuation.

25.19 Provisional Closure

The role of this final section is to close the present book without converting the framework it develops into a final system. The preceding sections have reconstructed the architecture of Generative Relational Economics (GRE), distinguished its epistemic statuses and programme commitments, specified its non-commitments, developed conditions of contestability and provenance, opened the framework to re-epistemization and domain evidence, disciplined cross-domain learning, described theoretical evolution, treated economic futures as historically open, and stated attentional disciplines for research and practice. Section 586 then identified major unresolved research fronts. The remaining task is therefore neither to add another substantive layer nor to summarize every concept introduced in the book. It is to state what kind of closure is warranted by the present version of the programme and what responsibilities remain attached to any continuation of it.

The argument proceeds through eight dimensions: bounded framework completion, research-programme identity, dialogical use, counterexample admission, revision architecture, collaborative development, open economic futures, and programme continuation. The method is synthetic and dependency-sensitive. Each dimension states what can presently be treated as complete enough for use while preserving the distinctions, uncertainties, domain limits, and defeat conditions on which that use depends. The resulting closure is versioned: it identifies a coherent research object that can be criticized, extended, or replaced without implying that later work must preserve every present formulation.

Definition 25.564 (Provisional closure). *Provisional closure* is a programme state in which a framework is sufficiently specified for identification, use, criticism, comparison, and continuation, while its substantive claims, representations, methods, normative commitments, domain boundaries, and future architecture remain open to revision under stated evidential and argumentative conditions.

Provisional closure therefore has two requirements. The framework must be determinate enough that disagreements can have identifiable targets, and it must remain corrigible enough that evidence or argument can change those targets or their status. Closure without determinacy produces an indeterminate label. Closure without corrigibility produces a protected doctrine.

Definition 25.565 (Book-level closure state). A *book-level closure state* records which conceptual structures, programme commitments, methodological disciplines, formal representations, substantive propositions, open problems, limitations, and research interfaces have been developed to a level sufficient for the present book, together with the elements intentionally left provisional or unresolved.

The present book-level closure state includes a historical and disciplinary account of GRE, ontological and epistemological foundations, research and applied praxis, substantive economic concepts, analyses of power and epistemic economy, AI-era capability asymmetry, domain studies, theoretical dialogues, cross-domain interfaces, limitations, and an open research-programme architecture. Completion at this level means that these components can be related within a coherent manuscript. It does not imply empirical completion, formal completion, normative convergence, or final theoretical adequacy.

Proposition 25.566 (Closure discipline). *A provisional GRE closure is warranted when the framework is identifiable enough to support cumulative inquiry and contestation,*

Table 25.19: Dimensions of provisional GRE closure and their principal continuity requirements

Closure dimension	Present programme status	Principal continuity requirement
Bounded framework completion	A coherent, usable architecture with explicit scope and unresolved objects	Preserve distinctions between completion of the book and completion of the research programme
Research-programme identity	A reconstructable commitment structure rather than fixed doctrinal content	Keep identity contestable through versioning, lineage, and successor recognition
Dialogical use	A language for comparison, translation, reconstruction, and disagreement	Preserve domain predicates, translation remainder, and alternative vocabularies
Counterexample admission	Negative and contrary evidence can target identifiable GRE claims	Maintain defeat paths and protect counterexamples from retrospective absorption
Revision architecture	Claims and representations can change status, scope, or form	Preserve reasons, dependencies, superseded states, and revision consequences
Collaborative development	Programme work can be distributed across disciplines, communities, and publics	Preserve correction authority, provenance, authorship, and responsibility across collaboration
Open economic futures	Economic orders remain contingent objects of inquiry and praxis	Evaluate generative consequences without deriving one terminal economic arrangement
Programme continuation	Later work inherits a versioned framework rather than a finished canon	Carry forward questions, evidence obligations, limitations, and permission to transform the programme

its unresolved objects and limitations remain explicit, and later revision can alter the framework without requiring that every change be redescribed as either confirmation or external rejection.

Table 25.19 summarizes the eight dimensions through which the present section states this closure.

Proposition 25.567 (Completion principle). *Completion of the present manuscript changes the status of GRE from a dispersed set of developing arguments into a more reconstructable programme formulation; it does not by itself strengthen the empirical, formal, historical, or normative warrant of claims beyond the support established within their respective chapters.*

This distinction governs the remainder of the section. A completed book can provide a stable object for criticism precisely because it no longer needs to remain fluid at every sentence. Stability of the object of criticism is compatible with revisability of the programme that the object represents.

25.19.1 Bounded Framework Completion

The present GRE formulation is best understood as a framework with bounded completeness. It has enough internal structure to guide research questions, organize distinctions, support formal and empirical programmes, and expose its dependencies. At the same time, many of its concepts remain preliminary, several formalizations are intentionally non-exclusive, and the empirical range of numerous propositions has not been established across the domains in which they might eventually be used. Bounded completeness recognizes both facts at once.

Definition 25.568 (Bounded framework completeness). *Bounded framework completeness* is the condition in which the principal objects, relations, distinctions, inferential pathways, scope limits, and open problems required for a stated programme version are specified well enough to support use and criticism within that version's declared domain.

This notion of completeness is relative to purpose. A framework can be complete enough to formulate a research programme while incomplete as a predictive theory. It can be complete enough to organize normative questions while leaving major normative disagreements unresolved. It can be complete enough to define a formal research direction while lacking a unique or empirically calibrated mathematical representation.

Definition 25.569 (Closure boundary). A *closure boundary* identifies which tasks, claims, derivations, validations, comparisons, or domain extensions are treated as completed for the current version and which remain outside that completion state.

The closure boundary protects the book from two opposite readings. One would treat every open problem as evidence that the framework has not been formulated at all. The other would treat manuscript completion as evidence that the programme's substantive questions have been settled. The present work supports neither reading. Its completion lies chiefly in the construction of a coherent architecture and a set of contestable research objects.

Proposition 25.570 (Bounded-completion condition). *A GRE component can be treated as complete for the present framework when its analytical role, dependencies, scope, epistemic status, and principal unresolved remainder are sufficiently explicit for later researchers to use or contest it without reconstructing the component from unstated assumptions.*

This condition also limits retrospective repair. Later investigators may improve definitions, correct arguments, introduce better evidence, or replace formal structures. Such changes should be recorded as revisions to an identifiable prior state rather than projected backward as if the earlier formulation had always contained them.

Definition 25.571 (Framework remainder). A *framework remainder* is an unresolved conceptual, evidential, formal, normative, historical, or domain-specific issue whose existence is compatible with present framework use but whose resolution could materially alter the programme's later form.

Framework remainder is therefore expected rather than anomalous. Section 586 records several high-leverage examples. Additional remainders will become visible only after the framework is used in domains and problems not considered in the present book.

Proposition 25.572 (Framework-use principle). *The present GRE framework should be used as a structured source of questions, distinctions, representations, and revisable claims rather than as an inference that economic phenomena are already exhaustively represented by the vocabulary developed here.*

Bounded framework completion thus provides closure at the level appropriate to a first integrated research programme. The resulting object is substantial enough to be judged and limited enough to be changed.

25.19.2 Research Programme Identity

A research programme requires continuity across change, but continuity does not require preservation of every present proposition. Sections 571, 575, 576, and 582 developed the relevant architecture: GRE has current commitments, plural formulations, historical versions, and possible transformation paths. Provisional closure now states how those elements relate at the point where the book ends.

Definition 25.573 (Programme identity profile). *A programme identity profile is a versioned record of the commitments, characteristic questions, analytical distinctions, domain orientation, methodological permissions, revision norms, and historical lineage through which a GRE formulation is presently recognized as belonging to the programme.*

The profile is more stable than any one model and less permissive than a name alone. Relational attention, generative attention, historical situatedness, value plurality, revisability, methodological pluralism, praxis orientation, domain specificity, and openness to counterevidence presently form a central identity kernel. Their future interpretation can change, and sufficiently deep changes can eventually justify recognition of a successor programme.

Definition 25.574 (Canonicalization pressure). *Canonicalization pressure is the tendency for historically contingent formulations, examples, diagrams, formalisms, or terminological choices to acquire authority because they appear in an early or influential programme text rather than because later inquiry continues to support their privileged status.*

Canonicalization pressure is likely in any programme that accumulates a literature. It can be useful when shared reference points reduce coordination costs, yet it becomes epistemically problematic when citation or repetition substitutes for renewed warrant. The appropriate response is not to prohibit canonical texts. It is to distinguish historical importance from current evidential or theoretical authority.

Definition 25.575 (Programme continuity test). *A programme continuity test evaluates whether a later formulation remains reconstructably connected to GRE through its questions, commitments, lineage, correction relations, and domain orientation, or whether accumulated changes are better described as producing a transformed branch or successor programme.*

The test is interpretive rather than algorithmic. Different researchers can reasonably disagree about the threshold of continuity. The important requirement is that the reasons for retaining or changing the programme label remain open to scholarly examination.

Proposition 25.576 (Identity-through-revisability principle). *GRE programme identity is strengthened when continuity can be reconstructed across explicit revisions, dis-*

agreements, negative results, and branch formation, because identifiable change provides a more discriminating continuity relation than preservation of terminology alone.

This principle gives the present book a limited constitutional role. It records a current programme state against which later states can be compared. It does not legislate the vocabulary or formalism that later GRE research must retain.

25.19.3 Dialogical Use of GRE

GRE has repeatedly been presented as a language of inquiry. The closing implication is that the framework should remain usable in dialogue with theories and disciplines that do not share its vocabulary. Dialogue is analytically productive when it clarifies correspondence, disagreement, remainder, and domain boundaries. It becomes unproductive when translation is used to assimilate every external claim into GRE terminology.

Definition 25.577 (Dialogical GRE use). *Dialogical GRE use* employs GRE concepts to formulate questions, reconstruct relations, compare accounts, or translate selected structures while preserving the independent predicates, evidential standards, and unresolved disagreements of the interlocutor theory or domain.

This use can occur within economics, across neighboring generative-relational domains, or in engagement with theories that reject major GRE assumptions. A dialogue does not require convergence. A clarified disagreement can be an adequate outcome when the underlying objects or warrants differ.

Definition 25.578 (Dialogue remainder). A *dialogue remainder* is a concept, predicate, explanatory commitment, evidential requirement, normative claim, or practical concern that remains materially significant after attempted comparison or translation and cannot be carried into the receiving framework without distortion or loss.

Dialogue remainder should remain visible. It can identify the boundary of a translation, expose an omitted domain predicate, or reveal that two apparently similar terms perform different theoretical roles.

Definition 25.579 (Reciprocal clarification). *Reciprocal clarification* occurs when comparison with another theory, method, discipline, or public vocabulary makes the commitments, limits, ambiguities, or evidential burdens of both sides more explicit, irrespective of whether substantive agreement increases.

This notion matters because GRE should not evaluate dialogue only by how much external material can be translated into its own architecture. External resistance can improve GRE by revealing where its categories are too broad, too narrow, historically local, normatively loaded, or empirically underspecified.

Proposition 25.580 (Dialogical non-absorption principle). *GRE dialogue is epistemically productive when translation and comparison generate reciprocal clarification while preserving domain-specific or theory-specific remainder that remains necessary for understanding the original object.*

A language for dialogue therefore gains value from disciplined limits on its reach. GRE can offer relational and generative questions without requiring those questions to become the sole grammar through which economic inquiry is conducted.

25.19.4 Counterexample Admission

A framework becomes meaningfully contestable only when contrary cases can alter the status of its claims. Sections 577, 578, and 586 developed criticism, negative-result preservation, and research maturation. The closing requirement is to treat counterexamples as programme evidence rather than as external interruptions that must be translated away.

Definition 25.581 (Admissible GRE counterexample). An *admissible GRE counterexample* is a well-specified empirical case, historical reconstruction, formal result, conceptual argument, normative challenge, or domain-specific finding that conflicts with a sufficiently identifiable GRE claim, proposed mechanism, scope statement, or representation under conditions relevant to that object's intended warrant.

Admissibility does not imply decisive defeat. A counterexample can reveal a measurement problem, hidden scope condition, missing variable, alternative mechanism, category error, or genuine failure. Its value lies in forcing the target claim to respond through a reconstructable inferential path.

Definition 25.582 (Counterexample response path). A *counterexample response path* records the challenged GRE object, the contrary evidence or argument, the relevance assessment, competing interpretations, resulting scope or status changes, and any unresolved disagreement after review.

Such a path makes post hoc accommodation visible. If every contrary case can be absorbed by expanding the meaning of a concept after observation, the concept loses discriminating force. A response path should therefore state whether the original formulation survives, narrows, branches, is replaced, or remains under dispute.

Definition 25.583 (Counterexample preservation duty). The *counterexample preservation duty* is the programme-level requirement to retain consequential negative or contrary results, including their original target and conditions, when later revisions would otherwise make the earlier failure difficult to reconstruct.

Preservation is especially important when a revised theory successfully handles a case that defeated an earlier version. The improvement is intelligible only if the earlier failure remains part of the theoretical history.

Proposition 25.584 (Counterexample productivity principle). A *counterexample improves GRE when it reduces unwarranted generality, reveals an omitted mechanism or domain condition, distinguishes competing formulations, or defeats a current claim in a manner that later researchers can reconstruct.*

The invitation to counterexample is therefore substantive. It requires stable targets, preservation of contrary results, and the possibility that the appropriate programme response is abandonment rather than repair.

25.19.5 Revision Architecture

Revision is the practical counterpart of contestability. A framework that accepts criticism in principle but lacks a way to alter its claims, dependencies, or programme records remains only rhetorically open. GRE therefore requires revisions to be attributable, scope-sensitive, and historically reconstructable.

Definition 25.585 (Revision obligation). A *revision obligation* arises when evidence, argument, domain correction, failed translation, normative reconsideration, or his-

torical change materially weakens the warrant of a GRE object relative to the claim strength, scope, or programme role presently assigned to it.

The obligation does not determine a unique revision. Reasonable alternatives can include narrowing a claim, changing its epistemic status, modifying definitions, separating domain variants, introducing an unresolved branch, or abandoning the object. What matters is that the weakening of warrant produces an explicit response rather than silent persistence.

Definition 25.586 (Revision adequacy). *Revision adequacy* is the degree to which a programme change addresses the evidence or argument that motivated it, propagates consequential changes through relevant dependencies, preserves the prior state and rationale, and avoids claiming more repair than the revision establishes.

A local wording change can be inadequate when a counterexample reaches a foundational dependency. Conversely, a major architectural revision may be unnecessary when the problem concerns a narrow empirical scope. Dependency-sensitive revision helps preserve proportionality.

Definition 25.587 (Revision remainder). A *revision remainder* is the portion of a motivating problem, disagreement, or uncertainty that remains unresolved after a revision and continues to constrain the warrant of the revised object.

Revision remainder protects against declaring a problem solved merely because a new formulation has been introduced. Later research should be able to see both what the revision repaired and what it left open.

Proposition 25.588 (Revision traceability principle). *Consequential GRE revisions should remain traceable from motivating evidence or argument through changed objects and dependencies to their resulting epistemic and programme statuses, including any unresolved revision remainder.*

This architecture supports intellectual continuity without enforcing doctrinal continuity. The programme can change substantially while retaining a transparent account of why it changed.

25.19.6 Collaborative Programme Development

GRE's unresolved questions exceed the competencies of any one researcher or discipline. Empirical validation, legal and institutional interpretation, historical reconstruction, formal development, ecological analysis, AI studies, normative inquiry, and public contestation each require forms of expertise that cannot be responsibly collapsed into one programme voice. Collaboration therefore belongs to the epistemic architecture of GRE rather than functioning merely as a strategy for increasing research volume.

Definition 25.589 (Collaborative GRE development). *Collaborative GRE development* is programme work in which multiple researchers, disciplines, communities, institutions, or affected publics contribute differentiated knowledge, criticism, evidence, interpretation, or revision while preserving the provenance and authority conditions of those contributions.

Differentiation is important. Collaboration does not require every participant to become a GRE theorist. A legal scholar can correct a legal-economic inference without accepting the entire GRE framework. A community can provide situated knowledge relevant to an intervention without assuming responsibility for the resulting theory.

A formal researcher can expose inconsistency without deciding the normative implications of the repair.

Definition 25.590 (Collaborative authority map). A *collaborative authority map* records which participants possess evidential, interpretive, methodological, normative, procedural, or decision authority over specified parts of a collaborative inquiry and where those forms of authority conflict or remain distributed.

The map helps prevent expertise in one domain from becoming presumed authority in another. It also makes visible when affected subjects possess experiential or practical knowledge while lacking institutional authority to alter the interpretation or use of that knowledge.

Definition 25.591 (Collaborative provenance). *Collaborative provenance* records the origin, transformation, attribution, contestation, and authorized use of contributions that enter a shared GRE research object or programme revision.

This requirement concerns more than authorship. It includes the conditions under which data were obtained, interpretations were negotiated, translations were made, objections were preserved, and local knowledge was abstracted into broader claims.

Proposition 25.592 (Collaborative correction principle). *GRE collaboration is epistemically valuable when differentiated contributors can correct the programme within domains where they possess relevant warrant, while the resulting synthesis preserves disagreement, provenance, responsibility, and limits on transfer beyond those domains.*

The invitation to collaboration is thus also an invitation to distributed correction authority. A programme that seeks cross-domain reach should expect some of its most important improvements to originate outside the communities that currently identify most closely with GRE.

25.19.7 Open Economic Futures

The programme's theoretical openness has an economic counterpart. Section 583 argued that GRE should not infer one terminal economic order from relational or generative premises. Provisional closure retains that claim at the book level. The framework can evaluate institutions, allocations, value conversions, power relations, ecological constraints, participation structures, and future option effects without treating one historically specific arrangement as the necessary destination of economic development.

Definition 25.593 (Open-future economic stance). An *open-future economic stance* evaluates economic arrangements through their situated consequences, values, constraints, generative conditions, participation structures, power relations, irreversibilities, and future revision capacities while withholding a presumption that one institutional endpoint is already entailed by GRE.

Openness does not suspend judgment. Some arrangements can be criticized under explicit empirical, legal, ecological, ethical, or political criteria. Rights and safety constraints can justify closure of particular options. Ecological limits can make some trajectories infeasible. The stance concerns the absence of a single theory-derived endpoint, not the absence of practical constraints or normative commitments.

Definition 25.594 (Future-generative evaluation). A *future-generative evaluation* examines how a present economic arrangement changes the capacities of later subjects to form relations, generate and convert value, participate in institutions, preserve or

recover options, contest inherited structures, and revise the conditions under which subsequent economic life is organized.

This evaluation extends analysis beyond immediate welfare or output without replacing those measures. It asks an additional question: what kinds of future action and relation become more or less reachable because of the present arrangement?

Definition 25.595 (Future foreclosure record). A *future foreclosure record* identifies materially relevant future options, relations, capabilities, institutional alternatives, ecological states, or value forms made substantially less reachable by a present economic decision, together with the affected subjects, justification, uncertainty, and expected reversibility of that foreclosure.

The record does not imply that foreclosure is always undesirable. Economic and institutional life requires commitments that close alternatives. The analytical requirement is to make consequential foreclosure visible when it bears on later generative capacity or justice.

Proposition 25.596 (Open-future responsibility principle). *GRE can support substantive evaluation of economic arrangements while preserving open economic futures when present decisions are assessed partly through the future capabilities, relations, value possibilities, revision capacities, and foreclosures they generate for affected subjects.*

The economic future therefore remains a domain of inquiry, judgment, institution building, and contestation. GRE contributes analytical attention to how present structures alter that future without claiming to pre-author it.

25.19.8 Programme Continuation

The final implication of provisional closure is continuation under explicit inheritance conditions. Later GRE work will encounter evidence, technologies, institutions, theoretical resources, political problems, ecological constraints, and social configurations that the present book does not anticipate. A continuation worthy of an open programme should therefore inherit more than terminology. It should inherit the obligations that make revision and correction possible.

Definition 25.597 (GRE continuation record). A *GRE continuation record* is a versioned handoff that identifies the inherited programme state, current commitments and non-commitments, active evidence and formal dependencies, known limitations, unresolved research objects, preserved counterexamples, domain interfaces, and changes introduced by the continuing work.

A continuation record can be implemented through publications, repositories, research notes, version histories, data documentation, formal specifications, or other durable scholarly media. Its conceptual purpose is to prevent continuity from depending only on memory or nominal affiliation.

Definition 25.598 (Responsible programme inheritance). *Responsible programme inheritance* occurs when later work uses, extends, or criticizes GRE while preserving enough of the inherited framework's provenance, scope, counterevidence, and unresolved remainder to distinguish faithful continuation, revision, branch formation, and successor development.

Responsible inheritance does not privilege fidelity over innovation. A later researcher may reject major parts of the present architecture. The requirement is recon-

structability: readers should be able to determine what was inherited, what changed, why it changed, and what consequences followed for the programme's identity and warrant.

Definition 25.599 (Continuation permission). *Continuation permission* is the explicit programme-level recognition that later investigators may revise terminology, replace formalisms, narrow or abandon claims, introduce new domains, alter normative assumptions, reorganize the architecture, or develop successor frameworks when evidence and argument warrant those changes.

This permission is constrained by scholarly responsibility rather than by doctrinal loyalty. Revision should remain attributable; borrowed ideas should retain provenance; counterevidence should remain visible; and claims should retain scope proportionate to warrant.

Proposition 25.600 (Continuation principle). *GRE continues as an open research programme when later work can inherit an identifiable framework, contest and revise its components, preserve the history and evidence needed to understand those changes, and recognize when accumulated transformation is better represented as a branch or successor rather than as unchanged programme continuity.*

Definition 25.601 (Provisional-closure handoff). The *provisional-closure handoff* is the programme state established at the end of the present book: a bounded and identifiable GRE framework, a stated set of commitments and non-commitments, a record of formal and substantive constructions, explicit limitations and unresolved research fronts, mechanisms for counterexample and revision, interfaces for collaboration and cross-domain correction, and permission for later transformation under reconstructable scholarly lineage.

Proposition 25.602 (Provisional-closure integration principle). *The present book is provisionally closed when its framework can be handed forward as a coherent but defeasible research object whose future value depends on continued inquiry, empirical and historical testing, normative argument, formal clarification, domain correction, criticism, and revision rather than on preservation of the present text as a final authority.*

This handoff states the endpoint appropriate to the book. GRE has been developed here as an economic research programme concerned with relations, generative conditions, heterogeneous value, conversion and circulation, historical formation, power, knowledge, capability, praxis, and the future consequences of economic organization. The programme has also been required to expose its own limits: its representations are not proofs of ultimate ontology; its formalisms remain plural and revisable; generativity does not by itself establish normative priority; domain translations can fail; historical categories can drift; counterexamples can narrow or defeat claims; and future evidence can reorder the architecture.

The resulting closure is therefore substantive without being terminal. Researchers can now ask whether GRE concepts discriminate useful economic structures, whether proposed mechanisms survive empirical and historical testing, whether its value and justice analyses clarify problems left obscure by existing approaches, whether its formal representations improve explanation without outrunning evidence, and whether its domain interfaces produce genuine correction rather than terminological expansion. Practitioners can ask whether GRE attention to uncertainty, relation, power, reversibility, participation, value conflict, and learning improves intervention design in particular settings. Other disciplines and publics can challenge the programme where its economic vocabulary fails to represent their objects or where its claims ex-

ceed their warrant.

The book closes by leaving these questions answerable. Its most durable contribution would therefore not be the preservation of every present proposition, symbol, or term. It would be the establishment of a sufficiently explicit research architecture in which later scholars can determine what was claimed, what was assumed, what evidence was available, what remained unresolved, where disagreement entered, how revisions propagated, and why later formulations differ. Such reconstructability permits both continuity and departure.

Generative Relational Economics, in the version developed here, is consequently complete enough to enter sustained inquiry and incomplete enough to require it. The framework ends at a point from which criticism, empirical work, formal development, historical reconstruction, normative argument, practical experimentation, cross-domain comparison, and theoretical transformation can proceed without presuming their outcomes. That is the intended meaning of provisional closure.