

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 meaningful; 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 theoretical claims, observations, models, historical reconstructions, interpretations, inter-

ventions, 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

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

function is neither to shield GRE from evidence nor to convert every empirical pattern 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 interpretation 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 parameteri-

zation. 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 defi-

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

dition 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.

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 provisional 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, relevant 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, normative, 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 constraints, 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.

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

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 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; infor-

mal 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 empirical 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 remain-*

der 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 condition* 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 service, a place in an educational programme, a procurement contract, a legal en-

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

titlement, 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, re-*

distribution, 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, coordi-

nation 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 liabili-*

ties 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, learning, 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 re-*

mainder 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 mechanisms 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 re-

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

cover 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 failure 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 occurs 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 incommensurability 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 recogni-

tion 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 legitimacy, 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.

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

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 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 economic 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 de-

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

limited 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.

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 relative 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 topo-

logical 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 necessity, 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, return, 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. Longi-

tudinal 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.*

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

Table 22.8: Principal research domains in generative return

Research main	do-	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	sys-	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

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, infrastructures, 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 gen-

erative 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 future 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, and historical contingency. 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

Table 22.9: Principal research domains in generative spacetime

Research main	do-	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 continuity		Sequence-sensitive branching of later possibility	Establish plausible branch points, enabling conditions, reinforcement, and limits of historical portability

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, 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, constraint, 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 ad-

equate 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, organizational 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 alternative* 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.

22.10 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 22.475 (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 22.476 (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 22.477 (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 22.478 (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 22.479 (Fast-process identification profile). A *fast-process identification 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 22.480 (Fast-process evidence condition). A *fast-process claim* should identify rapid adjustment in the underlying process rather than infer speed solely from

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

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 22.481 (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 22.482 (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 22.483 (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 22.484 (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 22.485 (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 22.486 (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 22.487 (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 22.488 (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 22.489 (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 22.490 (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 22.491 (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 22.492 (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 22.493 (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 22.494 (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 22.495 (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 22.496 (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 22.497 (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 22.498 (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 22.499 (Cross-frequency coupling profile). A *cross-frequency coupling pro-*

file 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 22.500 (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 22.501 (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 22.502 (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 22.503 (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 22.504 (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 22.505 (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 22.506 (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 22.507 (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 22.508 (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 22.509 (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 22.510 (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 22.511 (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 22.512 (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 22.513 (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 22.514 (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 22.515 (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 22.516 (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 22.517 (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 22.518 (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 22.519 (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 22.520 (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 22.521 (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 22.522 (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 22.523 (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 22.524 (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 22.525 (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 22.526 (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 22.527 (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 22.526 and 22.527 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 22.528 (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 22.528 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 22.529 (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 22.529 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 22.530 (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 22.531 and Proposition 22.530 make resource power mechanism-dependent. Empirical designs can therefore compare nominal holdings with actual

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		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

command, drawdown rights, access restrictions, liquidity, delivery capacity, and the consequences of withdrawal or repricing.

Definition 22.531 (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 22.532 (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 22.532 is especially important for credit,

housing, energy, healthcare, specialized inputs, emergency finance, and other settings 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 22.533 (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 22.534 (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 22.533 and Proposition 22.534 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 22.535 (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 22.536 (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 22.535 and Proposition 22.536 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 22.537 (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 22.538 (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 de-*

pendence.

Definition 22.537 and Proposition 22.538 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 22.539 (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 22.540 (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 22.539 and Proposition 22.540 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 22.541 (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 22.542 (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 22.541 and Proposition 22.542 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 22.543 (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 22.544 (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 22.545 (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 22.543 and 22.544, together with Proposition 22.545, 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 22.546 (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 22.547 (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 22.546 and Proposition 22.547 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 22.548 (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 22.549 (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 22.548 and the uptake requirement in Proposition 22.549 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 22.550 (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 22.551 (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 22.552 (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 22.550 and 22.551, together with Proposition 22.552, 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 22.553 (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 22.554 (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 22.553 and Proposition 22.554 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 22.555 (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 con-

ditioning capacity.

Proposition 22.556 (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 22.555 and Proposition 22.556 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 22.557 (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 22.558 (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 22.557 and Proposition 22.558 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 22.559 (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 22.560 (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 22.559 and Proposition 22.560 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 22.561 (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 22.562 (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 22.563 (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 22.564 (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 22.565 (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 22.561, 22.562, and 22.564 specify the principal research records for interface control. Propositions 22.563 and 22.565 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 22.566 (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 22.567 (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 22.566 and Proposition 22.567 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 conse-

quential 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 22.568 (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 22.569 (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 22.568 and 22.569, together with Proposition 22.570, 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 22.570 (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 22.571 (Routing-power profile). A *routing-power profile* records how a position can direct circulation toward, away from, through, or around specified nodes, domains, scales, or populations and the consequences of alternative routing decisions.

Definition 22.572 (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 22.573 (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 22.571 and 22.572, together with Proposition 22.573, 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 22.574 (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 22.575 (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 22.574 and Proposition 22.575 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 22.576 (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 22.577 (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 22.578 (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 22.576 and 22.577, together with Proposition 22.578, 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 22.579 (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 22.580 (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 22.579 and Proposition 22.580 provide a narrower test for capture claims grounded in residual authority.

Definition 22.581 (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 22.582 (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 22.581 and Proposition 22.582 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 22.583 (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 22.584 (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 22.583 and Proposition 22.584 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 22.585 (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 22.586 (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 22.585 and Proposition 22.586 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 22.587 (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 22.588 (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 22.587 and Proposition 22.588 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 22.589 (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 22.590 (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 22.589 and Proposition 22.590 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 22.591 (Longitudinal power ledger). A *longitudinal power ledger* is a versioned research record that tracks the identified power form, carrier, affected positions, mechanism, evidence, alternatives, reproduction pathways, counter-power, structural breaks, and claim-status revisions across time.

Proposition 22.592 (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 22.591 and Proposition 22.592 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 22.593 (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 22.594 (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 22.593 and 22.594 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,

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

or historically produced; or they can diverge because one study omits affected positions that another study identifies through broader incidence tracing.

Proposition 22.595 (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 22.595 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 22.596 (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 conditions, burdens and protections, resulting capabilities or opportunities, and the normative principle used to evaluate the distribution.*

Definition 22.596 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 22.597 (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 22.597 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 22.598 (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, con-

testability, 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 22.599 (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 22.600 (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 22.601 (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 22.602 (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 22.603 (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 22.604 (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 22.605 (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 22.606 (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 22.607 (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 22.608 (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 22.609 (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 22.610 (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 22.611 (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 22.612 (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 22.613 (Conversion-justice contestability). *Conversion-justice contestability* is the practical capacity of affected positions to obtain reasons for conversion decisions, 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 22.614 (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 22.615 (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 22.616 (Circulation-governance incidence). *Circulation-governance incidence* 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 22.617 (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 22.618 (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 22.618 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 22.619 (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 22.620 (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 22.621 (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 22.622 (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 positions. 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 22.623 (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 22.624 (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 22.623 and 22.624 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 22.625 (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 22.626 (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 22.627 (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.

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

Proposition 22.628 (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 22.628 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 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 22.629 (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 22.630 (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 co-operative 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 22.631 (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 22.632 (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 22.633 (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 22.634 (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 actors 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 22.635 (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 22.636 (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 22.637 (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 22.638 (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 22.639 (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 unavailable 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 22.640 (Option-foreclosure trace). *An option-foreclosure trace links a pre-*

viously 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 22.641 (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 material 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 22.642 (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 22.643 (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 22.644 (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 22.645 (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 22.627. 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 22.646 (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 deep-

ens. *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 22.647 (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 22.648 (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 22.648 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. Publication 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 22.649 (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 22.649 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 22.650 (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 22.650 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 repli-

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

cation process, and the receiving field. A corpus can become larger while remaining inaccessible to a relevant population. Searchable records can expand while linguistic 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 22.651 (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 22.651 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 abun-

dance 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 22.652 (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 22.653 (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 22.653 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 22.654 (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 22.655 (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 ev-

ery 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 22.656 (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 22.657 (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 22.658 (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 22.659 (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 programme 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 22.660 (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 22.661 (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 22.662 (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 22.663 (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 22.664 (Generative-capacity asymmetry condition). A *claim of consequential unequal generative capacity* should specify the epistemic functions being com-

pared, 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 22.665 (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 22.665 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 22.666 (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 22.666 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 22.667 (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 22.667 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 per-

formance, 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 22.668 (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 22.668 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 22.669 (Radical-asymmetry identification condition). An *AI-mediated capability 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 22.669 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.

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

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 expe-

rience, 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 22.670 (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 22.670 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 22.671 (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. Re-

search 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 22.672 (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 22.673 (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 22.674 (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 22.674 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 22.675 (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 22.676 (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 22.677 (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 22.678 (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 22.679 (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 22.680 (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 22.681 (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 22.682 (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 22.683 (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 22.684 (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 22.685 (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 22.686 (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 fallback 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 22.687 (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 22.687 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 22.688 (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 22.688 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 22.689 (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 22.689 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 can become partly a public-infrastructure study when access to essential activity depends on the platform.

Proposition 22.690 (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 22.690 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.

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, gate-keeping, 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

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 22.691 (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 22.692 (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 22.693 (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 22.694 (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 22.695 (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 variation 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 22.696 (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 22.697 (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 configuration 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 22.698 (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 22.699 (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 relations 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 22.700 (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 22.701 (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 22.702 (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 22.703 (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 22.704 (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 22.705 (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 22.706 (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 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, switch-

ing, 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 22.707 (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 22.708 (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 22.709 (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 22.710 (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 22.711 (Domain-study research-programme closure). *Within GRE, do-*

main 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 22.711 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 22.712 (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 22.712 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 22.713 (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 22.713 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.

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

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

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 22.714 (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 22.715 (Dynamic-structure identification condition). A claim that an ob-

served 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 22.716 (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 22.717 (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 ontological 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 22.718 (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 22.719 (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 22.720 (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 22.721 (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 22.722 (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.

Proposition 22.723 (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 22.724 (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 22.725 (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 22.726 (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 22.727 (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 22.728 (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 22.729 (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 22.730 (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 22.731 (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 22.732 (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 22.733 (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 $\mathcal{S}$ 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 22.734 (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 22.735 (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 2-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.

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-order structures should correspond to an analytical relation that pairwise links fail to preserve. If the empirical material supports only a sequence, the richer complex should remain unused.

Definition 22.736 (History-complex construction protocol). *A history-complex construction protocol specifies event boundaries, partial-order relations, admissible transitions, higher-order incidence, boundary configurations, empirical provenance for each encoded relation, unresolved ordering, and the analytical question that requires the complex rather than a simpler event graph.*

Partial-order and 2-complex models can interface naturally with generative space-time research, process tracing, transition kernels, and history weights. They are especially useful where the order and composition of events affects later accessibility while several paths remain possible.

Proposition 22.737 (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.*

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 22.738 (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 22.739 (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.

$$\mathcal{A}(B) = \sum_{h \in \mathcal{H}(B)} \mathcal{A}(h). \quad (22.6)$$

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 22.740 (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 22.741 (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 22.742 (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 22.743 (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 22.743 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 dependen-

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

cies support the claim.

Proposition 22.744 (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.

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 22.745 (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 22.746 (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 22.747 (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 22.748 (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 22.749 (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 ap-

pear 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 22.750 (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 22.751 (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 22.752 (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 22.753 (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 22.754 (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 automati-

cally 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 22.755 (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 22.756 (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 22.757 (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 22.758 (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; authoritative 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 22.759 (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 22.760 (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 22.761 (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, inter-

pretive 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 22.762 (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 22.763 (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 22.764 (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 22.764 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 of the same GRE object and therefore require translation before they are compared.

Proposition 22.765 (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: 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

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 22.766 (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 22.767 (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 22.768 (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 22.769 (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 research 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 22.770 (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 22.771 (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 22.772 (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 multi-level 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 22.773 (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 22.774 (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 22.775 (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 disconti-

nuity 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 22.776 (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 22.777 (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 22.778 (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 22.779 (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 alone 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 22.780 (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 22.781 (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 22.782 (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 22.783 (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 22.784 (Cross-method triangulation matrix). A *cross-method triangulation matrix* records the focal GRE claim, its component subclaims, methods used, man-

ifestations 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 22.785 (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 22.786 (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 22.787 (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

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

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 22.788 (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 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 22.789 (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 22.790 (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 22.791 (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 22.792 (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 22.793 (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 22.794 (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 22.795 (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 22.796 (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 22.797 (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 22.798 (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 22.799 (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 22.800 (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 22.801 (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 22.802 (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 22.803 (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 historically 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 22.804 (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 22.805 (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 22.806 (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 22.807 (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 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

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

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 22.808 (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 22.809 (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 misde-

scribed.

Definition 22.810 (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 22.811 (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 22.812 (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, informa-

tion, 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 22.813 (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 informal practice can become more consequential than the formal reform; or temporary discretion can become normalized after the experimental period.

Definition 22.814 (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 22.815 (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 22.816 (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 af-

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 22.817 (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 22.818 (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 22.819 (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 22.820 (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 22.821 (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 22.822 (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 22.823 (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 22.824 (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 22.825 (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 22.826 (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 22.827 (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 measure-

ment, 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 transformation 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 22.828 (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 22.828 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 22.829 (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 relational 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.

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 episodic responses to measurement	Trace reactivity, gaming, classification effects, burden, visibility shifts, and feedback from metrics into the measured field

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 22.830 (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 22.831 (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 22.832 (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 22.833 (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 22.834 (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 22.835 (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, re-

covery, 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 22.836 (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 22.837 (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 22.838 (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 22.839 (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 transformed 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 22.840 (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 mea-

sured 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 22.841 (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 22.842 (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 22.843 (Power-score nonuniversality). *A scalar power score has defensible GRE meaning only within a specified domain in which its components have a jus-*

tified 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 22.844 (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 22.845 (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 22.846 (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 22.847 (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 22.848 (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 22.849 (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 22.850 (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 22.851 (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 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 22.852 (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 con-

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

cerning 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 22.853 (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 22.854 (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 22.855 (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 22.856 (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 22.857 (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 22.858 (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 22.859 (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 22.860 (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 22.861 (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 22.862 (Comparative-defeater condition). *When a rival explanation ac-*

counts 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 22.863 (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 22.864 (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 22.865 (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 22.866 (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 categories, 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 22.867 (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 22.868 (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 22.869 (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 22.870 (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 22.871 (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 22.872 (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 histori-

cal explanations are often capable of accommodating complexity because they admit context, path dependence, multiple scales, and interaction. These are substantive advantages 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 22.873 (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 22.874 (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 22.875 (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 22.876 (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 22.877 (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 22.877 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 22.878 (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.

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?

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, 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 22.879 (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 22.880 (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 22.881 (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 22.882 (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 22.883 (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 22.884 (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 22.885 (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 22.886 (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 22.887 (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 22.888 (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 22.889 (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 22.890 (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 22.891 (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 22.892 (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 22.893 (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 22.894 (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 22.895 (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 22.896 (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 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 22.897 (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 22.897 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 22.898 (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.

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?

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 22.899 (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 22.900 (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 22.901 (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 22.902 (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 22.903 (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 22.904 (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 22.905 (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 22.906 (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 22.907 (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 22.908 (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 diver-

gence 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 22.909 (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 22.910 (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 22.911 (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 22.912 (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, methods 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 22.913 (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 technologi-

cal 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 22.914 (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 22.915 (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 22.916 (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 specified 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 22.917 (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 22.917 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 22.918 (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 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.

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

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 22.919 (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 con-

ventional 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 22.920 (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 22.921 (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 re-discovering the same failure without knowing its earlier conditions.

Proposition 22.922 (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 22.923 (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 22.924 (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 22.925 (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 22.926 (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 22.927 (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 22.928 (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 22.929 (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 compu-

tational 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 22.930 (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 22.931 (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 22.932 (Disagreement preservation condition). *A disagreement is pro-*

ductively 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 clarified, 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 22.933 (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 22.934 (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 responsibly answer in a later research environment.*

Definition 22.935 (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 22.936 (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 with-

out 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 22.937 (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 22.937 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 22.938 (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.

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

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 22.939 (Domain-specific finding profile). A *domain-specific finding profile* records an economic result together with its object, relation types, relevant actors 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 22.940 (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 22.941 (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 22.942 (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 22.943 (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 22.944 (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 appar-

ent 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 22.945 (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 22.946 (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 22.947 (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 22.948 (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 de-

termine 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 22.949 (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 22.950 (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 22.951 (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 22.952 (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 22.953 (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 22.954 (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 22.955 (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 22.955 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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