

Chapter 24

Limits, Open Problems, and the Future of GRE

Internal Fallibility and Open Problems

Chapter 24 examines the limits that arise *within* the claims undertaken by Generative Relational Economics (GRE). Chapter 23 established a disciplinary scope architecture: some predicates fall directly within GRE, some require partial explanation, some depend on neighboring domains, and some should remain current non-claims. That distinction prevents a disciplinary boundary from being misdescribed as a theoretical failure. The present chapter takes the complementary problem. Even where GRE has legitimate explanatory responsibility, its ontological commitments can be too strong, its observations incomplete, its reconstructions underdetermined, its formalizations misspecified, its historical claims too broad, its value classifications unstable, its interventions practically unsafe, or its empirical identifications unsuccessful. A research programme becomes answerable only when these possibilities are stated as part of the theory rather than treated as external qualifications added after substantive claims have been made.

The chapter therefore uses *limit* in a disciplined sense. A scope boundary identifies a claim that GRE does not presently undertake. An uncertainty concerns incomplete confidence within an undertaken claim. An open problem identifies a question whose resolution remains outstanding. A limitation identifies a condition that restricts the warrant, applicability, resolution, interpretation, or practical reliability of a GRE claim. A failure condition identifies evidence or inconsistency that would count against a claim rather than merely leave it incomplete. These categories can overlap in a concrete research project, but they perform different theoretical functions. Keeping them distinct makes it possible to ask whether a problem calls for better evidence, narrower scope, a different model, another domain's expertise, conceptual revision, or abandonment of the claim.

This chapter has four principal objectives. First, it develops a limitation architecture for GRE across ontology, epistemology, manifestation and representation, relational reconstruction, history, formalization, closure, value, power, justice, application, domain transfer, and AI-mediated inquiry. Second, it turns several substantive GRE concepts into explicit open research problems, including heterogeneous

value, value conversion, value circulation, generativity, power conversion, and long-horizon relational effects. Third, it specifies failure modes, counterevidence, and conditions under which GRE would require local or framework-level revision. Fourth, it converts those limitations into a research programme that can guide empirical design, interdisciplinary collaboration, replication, conceptual repair, and later theoretical development.

The method is reflexive but not self-protective. A limitation should not be stated so vaguely that every result can be assimilated after reinterpretation. Where possible, the chapter asks what observation, comparison, failed reconstruction, rival explanation, normative disagreement, or practical outcome would expose the limitation. Conversely, a limitation should not be inflated into global skepticism. A model can be useful under restricted conditions; a historical reconstruction can remain informative despite missing archives; a formal representation can clarify structure without establishing ontology; and an intervention can be justified under uncertainty when monitoring, reversibility, participation, and revision pathways are proportionate to the stakes.

Several distinctions developed earlier in the book remain controlling. Ontological reality is normally suspended rather than asserted; relational reality and manifestational reality should not be collapsed; observations and transformations remain differently typed; generation, conversion, circulation, return, capture, dissipation, and regeneration are analytically distinct; generativity is not equivalent to goodness; stability is not equivalent to justice; formal elegance is not empirical warrant; and cross-domain translation does not establish theoretical identity. Chapter 24 treats failures to preserve such distinctions as possible sources of internal error rather than stylistic imperfections.

The internal sequence proceeds from general limitation discipline to increasingly specific problems. Sections 546–553 examine theoretical, ontological, epistemic, representational, relational, historical, formal, and closure limits. Sections 554–559 examine value, incommensurability, conversion, circulation, power, and justice. Sections 560–564 address applied praxis, domain transfer, AI-era inquiry, empirical identification, and normative underdetermination. Sections 565–567 then ask how GRE can fail, what evidence would count against it, and what would require major revision. Section 568 converts the resulting limitation record into an explicit open research programme. The immediate task is to clarify why limitations belong inside theory construction itself and how doing so can strengthen rather than weaken the claims GRE makes.

24.1 Theoretical Status of Limits

Chapter 23 distinguished legitimate disciplinary restraint from failure inside GRE's own explanatory responsibilities. The present section establishes the corresponding internal discipline for Chapter 24. Its role is to explain why limitations are part of theoretical content rather than an appendix of cautions, to distinguish limitations from uncertainty, scope boundaries, open questions, and counterevidence, and to show how explicit limits support revisability, domain specificity, research design, practical

Table 24.1: Distinct roles of scope, uncertainty, limitation, open problems, and failure conditions in GRE

Category	Principal question	Research and theoretical response
Scope bound- ary	Is GRE responsible for this predicate?	Defer, share, or decline the claim; no internal failure is implied.
Uncertainty	How confident is the current inference?	Gather evidence, compare alternatives, or widen uncertainty representation; confidence can change without conceptual revision.
Limitation	Under what conditions is the claim reliable or interpretable?	State assumptions and restrict or redesign use; the claim remains but becomes conditionally specified.
Open problem	What unresolved question could materially change the framework?	Construct discriminating research designs; later inquiry can extend, narrow, decompose, or revise the claim.
Failure condi- tion	What finding would count against the claim?	Test, replicate, compare rival explanations, and revise if triggered; local or broader theoretical revision can become required.

responsibility, and future theory development. The objective is not to weaken GRE by surrounding every claim with qualifications. It is to make the strength of each claim legible: what the claim says, under which conditions it is warranted, what it leaves unresolved, how it could fail, and what kind of revision would follow. The method is claim-centered and versioned. Limits are attached to particular concepts, models, reconstructions, measurements, or interventions, and changes in those limits are treated as part of the history of the research programme.

The section begins from a distinction among five categories that can otherwise be conflated. A *scope boundary* concerns a claim outside GRE's present explanatory responsibility. An *uncertainty* concerns incomplete confidence in an undertaken claim. An *open problem* identifies a question that remains unresolved but researchable. A *limitation* restricts the conditions under which an undertaken claim can be interpreted, identified, generalized, or used. A *failure condition* identifies evidence or inconsistency that would count against the claim itself. These categories can interact, but they should not substitute for one another.

Definition 24.1 (GRE limitation). A *GRE limitation* is an explicit condition under which the warrant, identification, interpretation, applicability, comparative portability, or practical reliability of a GRE claim is restricted while the claim remains within GRE's stated explanatory scope.

Definition 24.2 (GRE open problem). A *GRE open problem* is a question whose resolution can materially alter the formulation, evidence, scope, comparison class, practical use, or revision status of a GRE claim and for which the research programme does not presently provide a settled answer.

Definition 24.3 (GRE failure condition). A *GRE failure condition* is a specified empirical, conceptual, formal, historical, or normative finding that would count against an undertaken GRE claim rather than merely indicate incomplete information about it.

Table 24.1 summarizes the distinction used throughout the chapter.

This taxonomy prevents two opposite errors. One is *protective relabeling*: counterevidence is redescribed as uncertainty or an open problem so that no claim can fail. The other is *failure inflation*: any uncertainty, missing observation, or disciplinary boundary is treated as evidence that the theory is false. An answerable research programme needs enough structure to avoid both.

24.1.1 Theoretical Content of Limits

A theory is usually presented through the objects it distinguishes, the relations it proposes, the mechanisms it describes, and the consequences it expects. Yet every such claim also carries conditions under which its terms can be identified and its inferences remain warranted. If these conditions are omitted, the theory can appear more general than the evidence allows. Limitations are therefore not merely external judgments about an otherwise complete theory. They partly specify the content of the theory by identifying where a distinction stops discriminating, where a reconstruction becomes underdetermined, where a model assumption ceases to hold, or where an intervention loses practical reliability.

Consider generativity. GRE can ask whether a resource, relation, institution, or intervention contributes to later capacities, relations, option-spaces, or value-generating processes. The analytical content of such a claim depends on a temporal horizon, a relevant population or relational configuration, an account of what is being generated, and an evidential route linking earlier conditions to later changes. If the horizon is unspecified, if the generated object cannot be distinguished from ordinary persistence, or if several rival mechanisms produce the same manifestation, the limitation is internal to the claim. It identifies what must be resolved before the claim can carry stronger explanatory weight.

The same logic applies to relational explanations. Saying that an outcome is relationally generated does not establish which relations are constitutive, which are background conditions, how the relevant boundary is drawn, or whether an alternative non-relational description explains the evidence more parsimoniously. A limitation statement can therefore sharpen the explanandum by requiring the research design to identify the relevant relational level and specify what evidence would distinguish competing reconstructions.

Proposition 24.4 (Limit-content principle). *For an answerable GRE claim, conditions that materially restrict identification, interpretation, scope, or practical use belong to the claim's theoretical specification rather than to an optional catalogue of external caveats.*

This principle does not require maximal qualification. A theory would become unusable if every logically possible exception were enumerated. The relevant limits are those that can change the meaning, evidential burden, comparative interpretation, or actionability of the claim. Their inclusion should increase discriminating content rather than merely lengthen the text.

24.1.2 Revision Conditions

Explicit limits make revision more precise. Without them, a failed prediction or problematic case can produce an unstructured choice between defending the entire framework and abandoning it. A limitation architecture permits more local responses. A measurement problem can be repaired without changing ontology. A failed formal closure can require a different model while preserving the substantive distinction under study. A historical counterexample can narrow a generalization without invalidating the mechanism in the settings where it remains supported. A normative disagreement can expose underdetermination without refuting a descriptive finding.

Definition 24.5 (GRE revision trigger). A *GRE revision trigger* is an observation, counterexample, failed identification, internal inconsistency, rival explanation, practical outcome, or domain correction that activates a previously stated limitation or failure condition strongly enough to require reconsideration of an affected claim.

Definition 24.6 (GRE revision pathway). A *GRE revision pathway* is the documented sequence through which a triggered limitation produces a local repair, scope restriction, semantic retyping, model replacement, decomposition, evidential downgrade, or broader framework revision.

Revision should preserve theoretical memory. If a formulation is narrowed after a counterexample, the earlier formulation and reason for revision remain analytically useful. They show which assumption failed and prevent future researchers from unknowingly reconstructing the same overclaim. A versioned limitation record therefore complements the scope and generalization ledgers developed in Chapter 23.

Proposition 24.7 (Local-revision presumption). *When counterevidence targets a separable claim, GRE should revise that claim locally before inferring failure of more general commitments; broader revision becomes warranted when the failure is shown to propagate through shared definitions, assumptions, or inferential dependencies.*

The presumption is methodological, not protective. Some failures do propagate. An inconsistency in a core distinction can affect many later claims. A recurrent inability to identify generativity could weaken a substantial part of the programme. The point is to trace the dependency rather than infer the scale of revision from the emotional or rhetorical importance of the challenged claim.

24.1.3 Domain-Specific Limitation Profiles

GRE is domain-specific even when it uses concepts with broader relational analogues. Its limitations should therefore also be typed by domain. Economic value conversion can face identification problems that do not arise in the same form in aesthetics or law. Economic participation can be measured through access, bargaining, institutional voice, or capability while political participation carries different constitutive and normative conditions. An empirical limitation in one domain should not automatically be promoted into a general limitation of every GR-oriented theory.

A useful limitation record consequently needs both a claim and a domain index. It should state whether the problem arises from economic institutions, the historical setting, a particular measurement technology, a formal representation, the available data, or a more general conceptual assumption. The distinction matters for future

GRT work because a limitation that disappears after domain reconstruction is evidence against premature generalization, whereas a limitation that independently reappears across heterogeneous domains may itself identify a candidate general research problem.

Definition 24.8 (Domain-specific limitation profile). *A domain-specific limitation profile records a claim's limiting conditions together with the domain objects, institutions, evidential access, historical setting, methods, and external warrants that generate or mediate those limitations.*

Proposition 24.9 (Limit non-transfer principle). *A limitation identified in GRE should not be assigned automatically to another GR domain or to a future GRT; its portability requires independent reconstruction of the mechanism or condition that generated the limitation.*

This also applies in the opposite direction. A legal or ecological limitation can constrain an economic claim when the claim depends on a legal or ecological premise, but the route of dependence should be explicit. Chapter 23 described such relations through external-warrant dependencies. Chapter 24 adds the requirement that limitations on those premises propagate only through the claims that actually depend on them.

24.1.4 Epistemic Restraint

Epistemic humility in GRE should be operational rather than ceremonial. Statements such as “the evidence is limited” contribute little unless the relevant limitation changes the claim, confidence, design, or decision. The stronger discipline is to identify what is unobserved, what reconstruction is non-unique, which alternative explanation remains plausible, which historical records are missing, or which parameter cannot presently be identified.

This is particularly important because much GRE inquiry has an inverse structure. Researchers observe manifestations and attempt to reconstruct latent relations, histories, constraints, or generative processes. Several underlying structures can sometimes produce similar manifestations. A limitation statement must therefore distinguish unavailable evidence from genuine non-identifiability. More data can reduce the former; the latter can persist even with extensive observation if the mapping from relational structures to manifestations is many-to-one.

Definition 24.10 (Calibrated epistemic restraint). *Calibrated epistemic restraint is the practice of matching the strength, resolution, and generality of a GRE claim to the available observational access, identification conditions, rival explanations, historical evidence, and model dependence relevant to that claim.*

Calibrated restraint permits strong conclusions where evidence is strong. It does not require every statement to remain tentative. A narrowly specified institutional mechanism can be well supported even when a wider historical or ontological interpretation remains unsettled. Conversely, mathematical precision cannot compensate for weak identification. Confidence should track the warrant attached to the claim rather than the sophistication of its representation.

Proposition 24.11 (Precision–warrant distinction). *Greater formal or numerical pre-*

cision does not by itself increase the epistemic warrant of a GRE claim when observational access, identification, historical evidence, or model adequacy remain weak.

24.1.5 Research-Design Consequences

A limitation becomes theoretically productive when it changes research design. If relation identification is uncertain, the design can collect multiple forms of relational evidence rather than only actor attributes. If historical categories change over time, the design can avoid treating a present classification as temporally invariant. If value forms are heterogeneous, measurement can preserve several value types instead of forcing early aggregation. If an intervention can alter the observational process, the research design can distinguish pre-intervention evidence from manifestations produced by the intervention itself.

The relevant movement is therefore from limitation to diagnostic question and from diagnostic question to method. A formal limitation can motivate sensitivity analysis or an alternative model class. An epistemic limitation can motivate triangulation or comparative reconstruction. A normative limitation can motivate explicit plural evaluation rather than silent substitution of one metric. A practical limitation can motivate staged implementation, monitoring, or reversible experimentation.

Definition 24.12 (Limitation-to-design mapping). *A limitation-to-design mapping connects a stated theoretical limitation to one or more research procedures capable of diagnosing, bounding, comparing, or reducing its effect without presuming that the limitation can always be eliminated.*

Proposition 24.13 (Research-design relevance). *A limitation statement has stronger research value when it implies observable diagnostics, comparison strategies, sensitivity analyses, alternative representations, or data requirements through which the affected claim can be challenged or refined.*

Some limitations will remain irreducible. Historical archives can be permanently lost; counterfactual trajectories can remain underdetermined; value conflict can persist after extensive deliberation. Research design should then represent the residual limitation rather than conceal it behind a single estimate or summary category.

24.1.6 Practical Responsibility under Limitation

Application changes the significance of uncertainty and limitation because theoretical error can alter institutions, resource flows, participation, capabilities, or future option-spaces. A limitation that is tolerable in exploratory modeling can become unacceptable when an intervention is difficult to reverse or when those bearing the downside have little influence over the decision. Practical responsibility therefore depends not only on estimated benefits but also on the structure of possible error.

GRE should distinguish at least four practical questions. First, who is exposed if the relational model is wrong? Second, which effects can be reversed or compensated? Third, who can detect and report emerging failure? Fourth, which institutional pathway permits the intervention to be modified or stopped? These questions connect epistemic limits to participation and power rather than treating uncertainty as merely statistical.

Definition 24.14 (Practical limitation burden). A *practical limitation burden* is the additional evidential, participatory, monitoring, reversibility, or safeguarding requirement created when a GRE-guided intervention can impose material consequences despite unresolved limitations in the underlying claim.

Proposition 24.15 (Stakes-sensitive responsibility). *The practical burden associated with a GRE limitation should increase with the magnitude, irreversibility, distributional concentration, opacity, and participation asymmetry of the consequences that can follow if the affected claim is wrong.*

This principle does not imply paralysis under uncertainty. Many economic decisions cannot wait for complete knowledge. It instead favors proportional safeguards and explicit revision pathways. An intervention can proceed under uncertainty when the reasons are stated, affected parties have appropriate standing, monitoring can reveal relevant failures, and institutions retain capacity to respond.

24.1.7 Constraints on Future Theory

Limitations also constrain how GRE should develop theoretically. New concepts should not be added only because an existing distinction encounters difficulty. Conceptual expansion can solve a local problem while reducing testability if every anomaly generates another flexible category. Future theory development therefore needs to record whether a new construction narrows ambiguity, creates new observable distinctions, improves comparison, or merely redescribes a failure.

The same discipline applies to formalism. A richer mathematical representation can expose structure that prose leaves ambiguous, but it can also hide unsettled semantics behind notation. Later formal development should identify which limitation it addresses and what new consequences become assessable. A formal extension earns theoretical status when it clarifies a relation, generates discriminating implications, or reveals inconsistency; elegance alone is insufficient.

Definition 24.16 (Limitation-guided theory development). *Limitation-guided theory development* is the extension, decomposition, or reformulation of GRE in response to a documented limitation whose proposed repair yields clearer semantics, stronger identification, better comparative discrimination, or more explicit failure conditions.

Limitations can therefore function as selection pressure on the research programme. Some will motivate narrower claims. Others will motivate new empirical methods or cross-domain collaboration. A smaller set may justify new concepts or formal structures. Still others may reveal that a favored distinction should be abandoned. The future of GRE is strengthened when these possibilities remain institutionally and conceptually available.

Proposition 24.17 (Repair-burden principle). *A proposed theoretical repair should identify the limitation it addresses and should add discriminating content or revision capacity sufficient to justify the additional conceptual or formal complexity it introduces.*

24.1.8 Research under Fallibility

Treating limitations as theoretical content can be mistaken for skepticism if fallibility is understood as the absence of warranted claims. GRE requires the opposite position.

Research can make locally strong claims while remaining explicit about the conditions that would narrow or overturn them. Fallibility concerns revisability in principle and answerability to evidence, not the refusal to distinguish better-supported explanations from weaker ones.

This orientation is especially compatible with the relational commitments of the book. Relations, institutions, meanings, and manifestations can change historically; observation can alter the system being studied; categories can become performative; and interventions can transform the conditions under which earlier findings were obtained. A claim that was well warranted in one period can therefore become less applicable without having been irrational when first made. Versioned limitations allow the theory to represent this temporal dimension of knowledge.

Definition 24.18 (Constructive fallibility). *Constructive fallibility* is a research orientation in which GRE permits strong, contestable claims while preserving explicit limitation profiles, failure conditions, revision triggers, and historical records through which those claims can be narrowed, repaired, or rejected.

Definition 24.19 (GRE limitation register). A *GRE limitation register* is a versioned record linking substantive claims to their scope status, uncertainty sources, limiting conditions, open problems, failure conditions, revision triggers, research-design responses, practical burdens, and subsequent theoretical changes.

The register makes limitation cumulative rather than repetitive. Later work need not rediscover that a formalism depended on closure, that a historical result relied on incomplete archives, or that a value conversion was only locally commensurable. It can test whether the limitation remains, has been reduced, has changed form, or has propagated into another part of the framework.

Proposition 24.20 (Limit-answerability principle). *A GRE claim is more theoretically answerable when its limiting conditions and possible failure states are explicit enough that later inquiry can distinguish confirmation, unresolved uncertainty, boundary restriction, local revision, and genuine counterevidence.*

The resulting stance is neither maximalist nor skeptical. GRE should state what it currently has reason to claim, the conditions supporting that claim, and the routes by which future evidence can change it. The present section therefore supplies the organizing discipline for the rest of Chapter 24. The next section applies it first to ontology, where the distinction between useful relational representation and stronger claims about what ultimately exists requires particularly careful restraint.

24.2 Ontological Limits

Chapter 4 introduced the ontological architecture used throughout this book: ontological reality is normally left under suspension; relational reality identifies historically generated configurations that persist with sufficient stability and causal efficacy to participate in subsequent relations; manifestational reality concerns the context-dependent forms through which realities become present to subjects, instruments, institutions, classifications, and other configurations. The present section returns to that architecture from a different direction. Its role is to identify the conditions under which those distinctions cease to warrant stronger conclusions, the assumptions they

leave open, and the kinds of evidence that would require ontological revision. The objective is therefore diagnostic rather than metaphysically constructive. The section examines ontological suspension, relational and manifestational reality, stronger ontological commitments, domain-specific ontologies, possible non-relational objects or properties, multiple realization, and the limits of relational primacy. Its method is internal criticism: the analysis asks what GRE currently commits itself to, what it deliberately leaves unsettled, and how its ontological vocabulary could become too strong, too weak, or insufficiently discriminating.

The starting point is a distinction between *ontological usefulness* and *ontological closure*. GRE needs objects, relations, events, constraints, processes, subjects, institutions, values, and histories that are real enough to enter explanation. An inquiry that refuses every ontological commitment cannot identify anything whose persistence or transformation matters. Yet explanatory usefulness does not establish that the selected categories are exhaustive, fundamental, uniquely individuated, or invariant across domains and scales. The ontological limitation problem begins precisely where a working analytical object is promoted into a stronger claim than the research question or evidence requires.

Definition 24.21 (Ontological limitation in GRE). An *ontological limitation in GRE* is a condition under which an object, relation, process, register, identity criterion, or ontological distinction remains analytically useful while the available warrant is insufficient to establish its fundamentality, exhaustiveness, uniqueness, cross-domain invariance, or independence from the boundary and scale of inquiry.

Definition 24.21 makes ontological limitation compatible with substantive explanation. A market can be treated as a relationally real institution without establishing that markets form an ultimate ontological kind. A person, organization, currency, legal category, artificial system, or ecological resource can be an economically consequential object without GRE resolving every metaphysical question about its constitution. The limitation lies in the distance between the strength needed for the analysis and the stronger claim that could be inferred from it.

Table 24.2 summarizes four recurrent ontological claim levels and the corresponding restraint required in this chapter.

The table is not a hierarchy in which stronger claims are always preferable. A research programme gains rigor when its ontological strength matches its evidential and explanatory burden. Excess strength creates overreach; insufficient strength can leave the objects of inquiry too indeterminate to support explanation. The relevant task is calibration.

24.2.1 Ontological Suspension

Ontological suspension is the principal device through which GRE separates local explanatory commitment from claims about ultimate constitution. It does not mean that the programme treats all ontological possibilities as equally plausible, or that it refuses to say what kinds of objects participate in economic explanation. Rather, it withholds stronger closure where several materially different ontological interpretations remain compatible with the evidence and where choosing among them would add little to the present explanatory task.

Table 24.2: Ontological claim levels and corresponding GRE restraint

Claim level	Legitimate analytical use	Principal ontological limitation
Operational object	Treat a configuration as stable enough for a stated inquiry.	Task-relative usefulness does not establish unique or fundamental identity.
Relational reality	Attribute persistence and causal efficacy within a specified generative-relational system.	Stability and efficacy do not establish exhaustive constitution or ultimate ontology.
Three registers	Separate ontological, relational, and manifestational questions.	The three-register architecture may require refinement, extension, or domain-specific reconstruction.
Stronger ontology	Assert a more specific account of what an object ultimately is or what kinds of reality are fundamental.	GRE requires additional warrant when the stronger commitment exceeds the explanatory needs of the economic inquiry.

This restraint has a positive analytical function. Suppose an institutional identity persists through changes in personnel, documentation, ownership, and internal procedure. GRE can investigate the relations that reproduce that identity, its effects on resource allocation, and its role in later value generation without first determining whether the institution should ultimately be understood as a legal fiction, a social object, a pattern of practices, an information-bearing organization, or another ontological kind. Suspension permits the inquiry to proceed on the structure shared by the interpretations that remain live.

Suspension nevertheless has limits of its own. If rival ontological interpretations generate materially different predictions, intervention consequences, identity criteria, or normative implications, continued suspension can obscure a disagreement that has become operative. A claim that an artificial system is merely an instrument and a claim that it possesses a form of subjecthood, for example, may be interchangeable for some productivity analyses while becoming highly consequential for responsibility, standing, or participation. GRE cannot resolve such questions solely because they become important, but it should identify the point at which its economic analysis begins to depend on an ontological premise supplied elsewhere.

Definition 24.22 (Ontological suspension boundary). An *ontological suspension boundary* is the point at which competing ontological interpretations cease to be interchangeable for a GRE claim because their differences alter the identification of objects, admissible mechanisms, expected consequences, intervention design, or evaluation of the economic process under study.

The boundary makes suspension conditional rather than indefinite. GRE can remain neutral where the disagreement is inert for its present purpose and should expose the dependency where the disagreement becomes consequential. This also prevents ontological suspension from functioning as a device for avoiding difficult evidence. If an explanation depends on treating an object as persistent across a transformation, the identity criterion supporting that persistence should be defended rather than placed under suspension after the fact.

Proposition 24.23 (Suspension calibration principle). *GRE should maintain ontological suspension when stronger alternatives are not discriminated by the relevant evidence or explanatory task, and should identify or import additional ontological warrant when those alternatives generate materially different consequences for an undertaken claim.*

The proposition preserves two kinds of humility. GRE should not promote analytical convenience into metaphysics. It should also not invoke suspension where its own claims already depend on a particular ontology. The limitation register introduced in Section 546 can therefore record whether an ontological issue is genuinely suspended, operationally fixed for a local task, or externally dependent on another domain's account.

24.2.2 Relational Reality

Relational reality is among the most consequential constructions in the book because it permits GRE to treat historically generated objects as real without requiring them to be fundamental substances. The criterion combines emergence within a generative-relational system, sufficient persistence over a relevant interval or region, and causal efficacy within later processes. Money, organizational identity, trust, debt, reputation, institutional authority, and many other economically consequential objects can be studied through this criterion.

The criterion also contains several limitations that become more visible when it is used empirically. First, persistence is scale-relative. A configuration can be stable for the duration of a transaction and unstable across a generation. Second, causal efficacy is boundary-dependent. A pattern that appears inert inside a narrow system may matter strongly once downstream or cross-domain effects are included. Third, emergence can be multiply reconstructible. Several histories can be compatible with the same present configuration. Fourth, causal efficacy can be difficult to distinguish from repeated analyst classification when the relevant intervention, counterfactual, or temporal evidence is weak.

Definition 24.24 (Relational-reality warrant profile). *A relational-reality warrant profile records the evidence supporting the emergence, persistence, causal efficacy, boundary, scale, and identity conditions under which an object is treated as relationally real in a particular GRE inquiry.*

The profile does not create a universal metric of relational reality. Its purpose is to expose the dimensions on which the attribution depends. Evidence can be strong for persistence and weaker for generative origin; strong for causal efficacy at one scale and uncertain at another. Recording these asymmetries is more informative than assigning a single degree of reality.

A second limitation concerns exhaustiveness. Demonstrating that an object is relationally real does not establish that its relevant properties are fully generated by the relations included in the model. A worker's legal position, physiological capacities, material environment, memory, or technical skill can enter an economic relation with histories and properties that are not reducible to the relation being studied. Relational reality therefore gives GRE a criterion for causal participation, not a license to explain every property through one relational system.

Proposition 24.25 (Non-exhaustiveness of relational reality). *Establishing that an object is relationally real within a specified generative-relational system does not establish that the object's constitution, capacities, identity, or causal powers are exhausted by the relations represented in that system.*

This proposition is important for the economic domain because economically relevant objects routinely cross disciplinary boundaries. A property right is relationally real within economic practice while its legal validity depends on legal institutions. An ecological object can constrain production while possessing biological or physical dynamics that economic relations do not generate. An AI system can occupy an economically consequential position while its technical architecture remains a distinct explanatory object. GRE should therefore use relational reality to identify participation and effect while preserving the possibility of constitutive remainder.

A third limitation concerns stabilization. Persistence and causal efficacy can arise through domination, coercion, path dependence, classification, or repeated institutional reinforcement. Relational reality is consequently descriptive before it is evaluative. Stable reality does not imply desirability, legitimacy, justice, or normative priority. Chapter 24 will return to these distinctions when considering power and justice; at the ontological level, the relevant point is that reality-status should not silently acquire evaluative force.

24.2.3 Manifestational Reality

Manifestational reality concerns the forms through which realities become available within a particular configuration of subject, instrument, institution, archive, interface, classification, language, or model. Prices, reports, rankings, measurements, legal records, narratives, images, dashboards, and experienced appearances can all participate in manifestation. GRE treats these forms seriously because manifestations can become causally consequential: a classification can redirect eligibility, a published index can alter expectations, and an AI-generated representation can change subsequent decisions.

The ontological limitation is that manifestation does not uniquely settle what is manifested. Similar manifestations can arise from different relational structures, and different manifestations can arise from the same relationally persistent object. A sudden price increase can manifest scarcity, strategic withholding, policy change, speculative expectation, measurement revision, or combinations of these mechanisms. A stable institutional label can persist while its underlying relations change substantially. An apparent change can also be produced by an altered measurement or classificatory system while the relevant relational structure changes less than the manifestation suggests.

These possibilities will receive a dedicated epistemic and representational treatment later in the chapter. At the present ontological level, they establish that manifestation should not be treated as a transparent identity relation between appearance and reality. The same caution applies in the opposite direction. A manifestation can become part of the causal organization of the system, so it should not be dismissed as merely secondary or representational.

Definition 24.26 (Manifestational ontological remainder). *A manifestational ontolog-*

ical remainder is the portion of an object's constitution, history, causal structure, or possible realization that is not fixed by a particular manifestation even when that manifestation is informative and causally consequential.

The remainder is not necessarily unknowable. Additional manifestations, interventions, historical evidence, technical inspection, or cross-domain inquiry can reduce it. The concept instead blocks the inference that one mode of access exhausts the object. It also allows GRE to compare manifestations without assuming that the comparison already supplies a common ontological measure.

Proposition 24.27 (Manifestation non-exhaustion). *A manifestation can provide evidence about, and can become causally involved in, a relationally real object while remaining insufficient to establish the object's complete ontological constitution or unique generative history.*

This proposition matters especially where economic governance relies on classifications and metrics. A credit score, productivity indicator, educational credential, risk category, or platform rating can have substantial economic reality because institutions act on it. Its efficacy does not establish that the category fully captures the person, organization, capability, or risk it represents. Ontological restraint therefore accompanies the practical seriousness of manifestation.

24.2.4 Stronger Ontological Commitments

GRE sometimes requires commitments stronger than generic ontological suspension. A research design may need to decide whether two observations concern the same object across time, whether a process continues through institutional change, whether a subject persists across changes in representation, or whether a material constraint exists independently of current recognition. These are ontologically substantive decisions because they determine what can enter causal and historical explanation.

The limitation question is not whether stronger commitment is prohibited. It is what burden should accompany the increase in ontological strength. Four considerations are especially relevant. The first is *explanatory necessity*: does the stronger commitment permit an inference that the weaker formulation cannot support? The second is *discriminating consequence*: would alternative ontological commitments produce observably or practically different implications? The third is *evidential accessibility*: what evidence could support or challenge the commitment? The fourth is *domain authority*: does GRE possess the relevant warrant, or does the claim depend on another discipline?

Definition 24.28 (Ontological escalation). *Ontological escalation* is the movement from a weaker analytical commitment to a stronger claim concerning the identity, constitution, persistence, fundamentality, or causal independence of an object or process.

Ontological escalation can be justified. A material intervention can show that a previously hypothetical constraint continues to operate across changes in representation. Legal analysis can establish that two organizational manifestations belong to the same juridical person for a specified purpose. Technical inspection can distinguish two computational systems that produce similar outputs while having materi-

ally different architectures. The relevant requirement is that the stronger claim earn its additional content.

Proposition 24.29 (Escalation burden). *A stronger ontological commitment in GRE should identify the additional explanatory work it performs, the evidence or external warrant that supports it, and the consequences that would differ if the commitment were weakened or rejected.*

This burden limits speculative accumulation. A framework does not become more rigorous simply by assigning more metaphysical detail to its objects. Additional commitments can reduce portability, create hidden dependencies, or generate false precision. Ontological strength is useful when it enables better discrimination, not when it merely thickens vocabulary.

The same principle applies to formal language. A 2-complex, field, state space, operator algebra, category, attractor, or other formal structure can represent selected aspects of economic or relational organization. Using the representation does not by itself escalate the ontological claim. Escalation occurs when the representation is asserted to reveal what the system ultimately is, or when alternative realizations are excluded without independent argument. Chapter 24 will examine these issues further under formalization limits.

24.2.5 Domain-Specific Ontologies

Chapter 23 established that neighboring domains can share objects while retaining distinct explanatory jurisdictions. Ontology follows the same discipline. An object can be economically real, legally constituted, politically authorized, socially recognized, ecologically constrained, technically implemented, and aesthetically experienced through partially overlapping but non-identical identity conditions. The fact that one empirical configuration participates in all of these domains does not imply that one domain's ontology should govern the others.

A corporation illustrates the issue. GRE can treat it as an economic subject or relational configuration when analyzing investment, employment, bargaining, production, or value circulation. Law can determine juridical personality, rights, liabilities, and continuity under transformations that economic analysis might classify differently. Political theory can ask about authority and accountability; social theory can examine organizational fields and identity; technical inquiry can treat computational infrastructure as a distinct component. These accounts can constrain one another while preserving different predicates and individuation rules.

Definition 24.30 (Domain-indexed ontological profile). *A domain-indexed ontological profile records how an empirical configuration is individuated, stabilized, and treated as causally or normatively consequential within a specified domain, together with the interfaces through which that profile depends on or conflicts with other domains.*

A domain-indexed profile helps prevent cross-domain vocabulary from producing hidden identity claims. Terms such as subject, institution, value, agency, property, person, resource, or environment can recur while carrying different constitutive criteria. The profiles can overlap substantially; some cases may eventually support stronger cross-domain structure. Their present similarity should nevertheless

remain a hypothesis to be established rather than an assumption inherited from common language.

Proposition 24.31 (Domain-ontology non-collapse). *Shared reference to an empirical configuration across domains does not by itself establish shared identity conditions, causal ontology, normative status, or explanatory priority across those domains.*

This proposition places a limit on GRE expansion. Economic importance cannot settle legal personality, moral standing, political membership, ecological identity, or technical agency. Conversely, a neighboring domain can correct the object structure used by GRE when its account reveals that an economically convenient category combines entities whose constitutive differences materially affect economic explanation. Ontological pluralism can therefore be a source of correction rather than a sign that the domains lack common objects.

24.2.6 Non-Relational Objects

A relational research programme faces a distinctive risk: once relation becomes analytically productive, every relevant feature can be redescribed as relational and the possibility of non-relational explanatory content can disappear by definition. GRE should avoid this closure. The present framework gives relations methodological and explanatory priority in many economic questions, but it does not establish that every causally relevant property is relationally constituted or that every adequate explanation must reduce its objects to relations.

The category *non-relational object* requires care. It can refer to an object whose existence is claimed to be independent of relations, to an intrinsic property that remains explanatory across changes in relation, or simply to a feature for which the relational constitution has not been demonstrated. These possibilities are different. GRE need not assert a metaphysics of intrinsic substance in order to recognize that some material, biological, technical, or logical properties may enter an economic explanation as constraints or capacities that the selected economic relations do not generate.

For example, the thermal tolerance of a material can constrain an industrial process. A physiological capacity can limit labor or care arrangements. A cryptographic property can constrain the feasible operations of a technical system. Each property can participate in relations and acquire economic consequences while its relevant causal structure may be better explained through another domain. Calling the consequence relational does not require claiming that the underlying property was generated by the economic relation.

Definition 24.32 (Relational adequacy challenge). *A relational adequacy challenge arises when an empirically consequential feature is not adequately identified, predicted, or explained by the relations represented in a GRE analysis and when an intrinsic, material, domain-specific, or differently structured account provides additional discriminating content.*

The challenge is methodological rather than an automatic refutation of relational analysis. The relevant response can be to enlarge the relational boundary, import another domain's mechanism, represent the feature as an exogenous condition, or revise the claim that the relation was constitutively sufficient. Different cases will

support different repairs.

Proposition 24.33 (Relational sufficiency test). *When a GRE explanation attributes an object's relevant capacity or outcome primarily to relational organization, the explanation should remain open to comparison with accounts in which some causally relevant properties are not generated by the represented relations.*

This proposition gives relational primacy an empirical vulnerability. If non-relational or differently constituted properties repeatedly explain outcomes that GRE attributes to relational structure, the appropriate response is not to redescribe those properties as relations by stipulation. The theory should narrow, decompose, or revise the attribution. A relational research programme remains informative only when relation excludes or differentiates alternatives rather than absorbing them terminologically.

24.2.7 Multiple Realization

Multiple realization creates a different ontological limit. Similar economic functions, relational positions, or manifestational outputs can be produced by heterogeneous underlying structures. A payment function can be realized through cash, bank deposits, mobile money, tokens, or institutional credit arrangements. Organizational memory can be realized through persons, documents, databases, routines, or combinations of these forms. Coordination can be realized through prices, rules, hierarchies, conventions, or technical protocols. Treating these realizations as equivalent for a specified purpose can be analytically useful while leaving their ontological and causal differences intact.

The converse problem also matters. Heterogeneous realizations need not imply distinct economic functions. If every material or institutional difference generates a new ontological category, the framework can lose the abstraction needed for comparison. GRE therefore needs identity criteria that state which differences are intentionally ignored for a given claim and which would alter the mechanism under study.

Definition 24.34 (Realization-sensitive equivalence). *A realization-sensitive equivalence is a task-relative judgment that heterogeneous realizations can be treated as equivalent with respect to specified functions, relations, or consequences while preserving the realization differences that remain causally, historically, normatively, or practically relevant.*

This definition provides a middle position between ontological collapse and excessive fragmentation. It allows a researcher to compare different monetary instruments as payment mechanisms while retaining differences in privacy, settlement risk, legal status, infrastructure dependence, or access. It allows AI-mediated and human-mediated tasks to be compared functionally while preserving differences in responsibility, embodiment, training history, or technical failure modes.

Proposition 24.35 (Multiple-realization restraint). *Functional or relational equivalence across heterogeneous realizations warrants only the equivalence dimensions established by the comparison; it does not establish ontological identity, identical causal mechanisms, or interchangeability under other tasks.*

Multiple realization also weakens simple inference from manifestation to consti-

tution. Two systems can produce similar outputs through different mechanisms, and one system can preserve its relevant function through substantial changes in realization. This reinforces the need for scale- and task-relative identity criteria. It also creates an empirical programme: research can ask which realization differences matter for generativity, power, robustness, justice, conversion, circulation, or long-horizon capability formation rather than assuming the answer from surface equivalence.

24.2.8 Limits of Relational Primacy

The strongest ontological limitation concerns the status of relation itself. GRE is relational in more than a descriptive sense. It repeatedly treats positions, capacities, values, identities, constraints, institutions, and historical trajectories as partly constituted through relations and through the generative histories of those relations. This orientation is theoretically productive because it reveals mechanisms that actor-isolated or static descriptions can miss. Its success nevertheless does not establish one undifferentiated thesis of relational primacy.

Three forms of primacy should be separated. *Methodological relational priority* means that an inquiry begins by examining relations and histories rather than assuming that isolated entities carry a complete explanation. *Explanatory relational priority* means that, for a specified phenomenon, relational organization explains more of the relevant variation or mechanism than rival descriptions centered on isolated properties. *Ontological relational priority* is stronger: it claims that relation is constitutively or fundamentally prior to the objects that enter it. GRE can adopt the first as a broad research orientation and establish the second locally where evidence supports it. The third requires additional argument and is normally left under suspension.

Definition 24.36 (Relational primacy profile). A *relational primacy profile* specifies whether a GRE claim assigns methodological, explanatory, or ontological priority to relations, together with the domain, scale, evidence, and alternatives against which that priority is asserted.

The profile prevents a common escalation. A study can show that network position predicts access better than an individual attribute without proving that the individual is ontologically constituted only by the network. Historical analysis can show that an institution emerged through relations without proving that every later property of the institution is reducible to the originating relations. A formalism can encode relational states without establishing that the world is fundamentally a relational state space.

The profile also creates explicit failure conditions. Explanatory relational priority should weaken when non-relational or differently structured rival models repeatedly identify mechanisms, predict outcomes, or support interventions more successfully for the same target. Methodological priority should be reconsidered when beginning from relational decomposition systematically obscures stable objects or properties that are needed for the inquiry. Ontological relational priority would require a much stronger evidential and philosophical burden than this book undertakes.

Proposition 24.37 (Bounded relational primacy). *GRE may give relations methodological priority and establish local explanatory relational priority while leaving universal ontological relational priority open to independent argument.*

Definition 24.38 (Ontological revision trigger). An *ontological revision trigger* is sustained evidence that GRE's current object distinctions, register architecture, identity criteria, relational attributions, or realization equivalences fail to preserve differences necessary for explanation, prediction, historical reconstruction, intervention, or cross-domain correction.

The trigger can produce several kinds of revision. GRE may narrow a relational claim, split one object category into several, merge previously distinct categories for a limited task, import a domain-specific ontology, weaken an identity criterion, revise the relation among ontological, relational, and manifestational registers, or abandon a stronger commitment that no longer performs defensible explanatory work. The three-register architecture itself remains open to such revision. Its present usefulness gives it standing within the research programme, not immunity from future counter-argument.

The ontological limits developed in this section therefore strengthen rather than empty GRE's commitments. The programme can treat historically generated economic objects as real and causally consequential, distinguish their manifestations from the realities they participate in, analyze multiple realizations, and place relations at the center of inquiry without converting these achievements into a closed metaphysics. The limitation grammar also identifies where failure could occur: relational-reality attributions can be weakly evidenced, manifestations can underdetermine constitution, stronger ontologies can exceed their warrant, domain ontologies can resist transfer, intrinsic or differently constituted properties can outperform relational accounts, and task-relative equivalence can be mistaken for identity. The next section turns from these ontological vulnerabilities to the epistemic problem they create: how GRE can responsibly infer relations, histories, mechanisms, and realities when observation is partial, situated, model-dependent, and often structurally indirect.

24.3 Epistemic Limits

The ontological restraint developed in Section 24.2 leaves GRE with a demanding epistemic problem. Economically consequential relations, histories, capacities, constraints, and generative processes can be real enough to matter while remaining only partially accessible to inquiry. The present section identifies the limits created by that gap between a relational target and the evidence available for reconstructing it. Its objective is to distinguish partial observation, latent and hidden relations, historical situatedness, observer participation, model dependence, inverse problems, and reconstruction limits as different epistemic vulnerabilities rather than treating them as one generic uncertainty. The discussion is analytical and methodological. It returns critically to epistemic resources developed earlier in the book and asks how those resources constrain the confidence, granularity, and revisability of GRE claims. Manifestation and representation have their own dedicated limits in the next section; the present concern is the warrant of inference from whatever evidential access is available.

Definition 24.39 (Epistemic limit in GRE). An *epistemic limit in GRE* is a condition

Table 24.3: Epistemic limits and corresponding disciplines in GRE inquiry.

Epistemic limit	Core problem	Required discipline
Partial observation	Relevant actors, relations, events, or intervals are observed unevenly	State coverage and visibility conditions; test sensitivity to plausible omissions
Latent relations	A relation may exist without being sufficiently discriminated in the current observation regime	Preserve inferential status and competing explanations
Hidden relations	Access to relevant traces is obstructed, concealed, or institutionally restricted	Require evidence of obstruction as well as evidence for the proposed relation
Historical situatedness	What can be known depends on historically changing categories, records, institutions, and access	Index claims to the evidential horizon and reconstruct changing conditions of knowability
Observer participation	Inquiry can alter access, behavior, disclosure, or the target relation itself	Record participation pathways and distinguish observation, elicitation, and intervention
Model dependence	Inference depends on analytical choices that privilege some structures over others	Compare substantively plausible models and report conclusions that are model-sensitive
Inverse problems	Multiple relational configurations can remain compatible with the same evidence	Retain compatibility classes and seek discriminating evidence rather than forced uniqueness
Reconstruction limits	Some histories or mechanisms remain permanently underdetermined	State recoverable cores, irrecoverable remainders, and the strongest warranted level of claim

under which the evidence, access, inferential bridge, observer position, historical record, or analytical model available to an inquiry does not support the full strength, uniqueness, granularity, or portability of a proposed relational or generative claim.

Definition 24.39 concerns warrant rather than the existence of the target. A weakly observed relation need not be ontologically weak. Conversely, a richly represented object need not be correctly reconstructed. The limitation grammar of Section 24.1 therefore applies at the level of specific epistemic claims: an inquiry should identify where access is incomplete, which alternatives remain live, and what kind of additional evidence could materially change the inference.

Table 24.3 summarizes the principal limits developed in this section and the corresponding discipline they impose on GRE inquiry.

24.3.1 Partial Observation

GRE often studies systems in which no observer has complete access to the relevant relational field. Administrative data may record transactions while omitting informal

obligations; interviews may reveal meaning while leaving organizational records inaccessible; platform logs may register interaction while concealing algorithmic ranking; archives may preserve one institution's correspondence while losing another's; longitudinal studies may cover some periods densely and others sparsely. Partial observation is therefore a structural feature of many GRE inquiries rather than an exceptional defect.

The central epistemic problem is coverage. An inquiry can observe many traces and still systematically miss the relations most consequential for the claim. Coverage should consequently be assessed across several dimensions: actors, relation types, temporal intervals, spatial or institutional domains, observational channels, and positions of differential visibility. A large dataset can remain epistemically narrow when all records originate from one institutional vantage point.

Definition 24.40 (Observation-coverage profile). An *observation-coverage profile* records the portions of a relational target that are directly observed, indirectly evidenced, inaccessible, unrecorded, or of uncertain status across the dimensions materially relevant to a specified claim.

The profile in Definition 24.40 should be claim-specific. A study of payment dependence may require dense transactional coverage but limited access to subjective meaning. A study of trust formation may require precisely the opposite. A historical study of institutional conversion may need temporal continuity more than contemporaneous breadth. The relevant question is therefore whether the observed field adequately covers the mechanism being claimed, rather than whether observation is complete in an abstract sense.

Partial observation becomes especially dangerous when missingness is patterned. Relations involving informal work, marginalized actors, confidential coordination, private care, failed transactions, abandoned projects, or politically weak organizations may leave fewer durable records than highly formalized relations. A reconstruction based on the surviving traces can then mistake observability for prevalence or institutional legibility for causal importance.

Proposition 24.41 (Coverage-sensitive inference). *The warranted strength of a GRE claim should decrease when plausible changes to unobserved or weakly observed portions of the target would materially alter the claimed relation, mechanism, or generative consequence.*

Proposition 24.41 does not imply that incomplete observation prevents strong inference. Some conclusions remain stable across wide ranges of plausible missingness. Others concern directly observed institutional relations whose relevant properties are well documented. The epistemic requirement is sensitivity: an inquiry should identify whether its conclusion survives realistic alternative reconstructions of the unobserved portions of the field.

24.3.2 Latent Relations

A relation can be relationally consequential while remaining insufficiently discriminated within the current observation regime. Earlier chapters used *latent relation* for such cases. The epistemic limitation is subtle because latency is compatible with

several states of affairs: a relation can be weakly manifested, manifested only under particular conditions, evidenced indirectly through consequences, or represented by traces that fail to distinguish it from rival relations.

GRE should therefore avoid treating latency as a synonym for invisible truth. A latent relation is an inferential candidate whose warrant depends on the structure connecting proposed relation, expected traces, observed traces, and alternatives. A recurring co-movement between organizations, for example, may be compatible with direct coordination, exposure to a common regulation, shared professional norms, imitation, or a common external shock. The proposed relation becomes better identified when the inquiry finds evidence that discriminates among these possibilities.

Definition 24.42 (Latent-relation warrant profile). A *latent-relation warrant profile* records the proposed relation, the indirect or conditional traces supporting it, serious alternative explanations, observations that would discriminate among those alternatives, and the consequences of misidentification for the substantive GRE claim.

The last component is important. Misidentifying a latent relation can have different consequences depending on the argument. If several candidate relations all imply the same broader dependence structure, the higher-level conclusion may remain robust even when the precise relation is unresolved. If the distinction determines whether an intervention targets trust, coercion, regulation, or shared exposure, the unresolved latency is much more consequential.

Proposition 24.43 (Latent-structure restraint). *GRE may infer a latent relational property at a level supported across plausible explanations while leaving more specific relational constitution unresolved.*

Proposition 24.43 permits epistemic progress under underdetermination. The appropriate response to a non-unique reconstruction is often to identify what is common to the viable accounts rather than to select one complete story prematurely.

24.3.3 Hidden Relations

Hidden relations differ from merely latent relations because access to relevant evidence is materially obstructed. The obstruction can arise through strategic concealment, confidentiality, secrecy, proprietary control, institutional exclusion, selective preservation, inaccessible infrastructures, language barriers, or the absence of channels through which some actors can produce recognized evidence. Hiddenness is therefore relational to an observation regime and to the distribution of epistemic access.

The concept carries a distinctive risk. Because the relation is partly hidden, an investigator can be tempted to treat the absence of confirming evidence as evidence of concealment. That move makes the hypothesis difficult to challenge. GRE should therefore require independent support for the obstruction mechanism as well as support for the substantive relation being proposed.

Definition 24.44 (Hidden-relation access profile). A *hidden-relation access profile* specifies the proposed relation, the expected evidential channels, the mechanisms restricting or distorting access to those channels, the traces of obstruction, and the alternative explanations compatible with the observed absence or irregularity.

Evidence of obstruction can include documented access restrictions, asymmetric record retention, unexplained deletion, legal confidentiality, restricted technical interfaces, contradictory public and private records, testimony concerning concealment practices, or systematic differences between groups in whose relations become institutionally visible. None of these automatically proves the hidden relation. They establish that non-observation should be interpreted through an access mechanism rather than treated as a neutral absence.

Proposition 24.45 (Dual burden for hidden relations). *A GRE claim about a hidden relation carries two evidential burdens: support for the proposed relation and support for the process that limits ordinary access to its traces.*

The dual burden in Proposition 24.45 is especially important in studies of power, capture, collusion, dependency, discrimination, and informal governance. These phenomena can genuinely involve concealment, yet their seriousness does not relax the evidential requirement. The framework should make hiddenness investigable without making it self-confirming.

24.3.4 Historical Situatedness

Economic knowledge is produced from historically situated evidence. Categories change, archives survive selectively, institutions alter recordkeeping, actors possess different concepts, technologies change what can be observed, and later researchers gain access to information unavailable to contemporaries while losing contextual knowledge that contemporaries took for granted. Epistemic limits are therefore indexed to time as well as to observer position.

Historical situatedness has at least two directions. A retrospective inquiry can know outcomes that earlier actors could not know, creating hindsight effects in the interpretation of decisions. At the same time, the retrospective inquiry can lose tacit context, routine knowledge, informal classifications, unrecorded alternatives, and records that did not survive. Later knowledge is consequently different from contemporaneous knowledge rather than uniformly superior to it.

Definition 24.46 (Historical epistemic horizon). *A historical epistemic horizon is the set of evidence, categories, methods, access conditions, expectations, and background knowledge reasonably available to a specified actor or inquiry at a specified historical time and location.*

The horizon in Definition 24.46 allows GRE to distinguish at least three questions: what actors could reasonably know at the time, what later researchers can reconstruct about their situation, and what contemporary theory can infer using concepts unavailable to those actors. These questions can yield different answers. A policy can be historically understandable under one information set and still be criticized under evidence then available but institutionally ignored. Conversely, later reconstruction can become overconfident when outcomes make one path look inevitable.

Proposition 24.47 (Historically indexed warrant). *Claims about historical knowledge, expectation, responsibility, or feasible choice should be evaluated relative to the relevant historical epistemic horizon rather than solely through the information available to later inquiry.*

Historically indexed warrant also constrains concept transfer. A category such as unemployment, disability, market power, citizenship, household, or intelligence can change in legal definition, administrative measurement, social meaning, and practical consequence. A time series may preserve a label while the object measured by that label changes. Historical epistemic discipline therefore requires reconstruction of category conditions as well as reconstruction of events.

24.3.5 Observer Participation

Observers can participate in the systems they study. Interviewers elicit accounts; ethnographers become recognized presences; surveys define answer categories; audits change organizational behavior; researchers request records that institutions assemble for the first time; experiments alter constraints; policy evaluations affect expectations; and publication can redirect subsequent attention. Observer participation is consequently a source of both epistemic access and epistemic transformation.

Participation should be distinguished from the performativity of representations discussed in the next section. The present issue concerns the observer's relation to evidence production and to the target system. A researcher can alter behavior before any formal representation is published. Participants can disclose information because trust develops, conceal information because observation becomes salient, or reorganize practices in response to being studied. These changes can reveal existing relations, create new relations, or do both.

Definition 24.48 (Observer-participation profile). An *observer-participation profile* records the observer's access, role, permissions, dependencies, elicitation methods, interventions, expected behavioral effects, and the pathways through which inquiry can alter the evidence or relational target relevant to a specified claim.

The profile resists two symmetrical errors. Treating the observer as external can hide constitutive features of the evidence-production process. Treating participation as disqualifying can discard knowledge available only through engagement. GRE instead requires the inferential consequences of participation to be made explicit.

Definition 24.49 (Discovery–creation ambiguity). *Discovery–creation ambiguity* arises when an observational or research intervention produces evidence compatible both with revealing a previously existing relation and with creating or strengthening the relation through the intervention itself.

Consider a coordination exercise that reveals actors can cooperate once a shared forum is provided. The result may disclose latent cooperative capacity, generate a new coordination relation, or combine both mechanisms. The economic consequences can be important in each case, but their historical and causal interpretation differs. GRE should therefore avoid treating post-intervention observability as uncomplicated evidence of pre-intervention existence.

Proposition 24.50 (Participation-aware inference). *When inquiry materially participates in evidence production, GRE should distinguish conclusions about the pre-observation system, the observer–system relation, and the system that exists after participation.*

24.3.6 Model Dependence

Relational evidence rarely enters analysis without modeling choices. Researchers decide which actors count as nodes, which interactions count as relations, how time is discretized, where system boundaries are placed, which categories are merged, which latent variables are introduced, how missingness is treated, and which mechanisms are admissible. Qualitative reconstruction is also model-dependent in this broader sense: a narrative selects events, causal links, temporal scales, and interpretive categories even when no mathematical model is used.

Model dependence becomes an epistemic limit when a substantive conclusion changes materially across several plausible analytical specifications. The existence of such dependence does not imply that models are arbitrary. Some specifications can be better supported by theory, evidence, institutional knowledge, or predictive and explanatory performance. The limitation concerns claims whose apparent stability derives mainly from one unexamined modeling frame.

Definition 24.51 (Model-dependence register). *A model-dependence register records the analytical choices that materially structure a GRE inference, the plausible alternatives to those choices, and which substantive conclusions remain stable, weaken, change sign, or disappear across those alternatives.*

The register should include conceptual as well as statistical choices. A study can be model-dependent because it represents a household as a unit rather than as an internal relation, treats a platform as a firm rather than as infrastructure, defines participation through formal membership, or chooses a short time horizon that suppresses delayed generative effects. Such choices can be analytically defensible while still delimiting what the resulting claim means.

Proposition 24.52 (Robustness without model neutrality). *A conclusion that remains stable across substantively plausible models has stronger cross-model warrant, while stability alone does not establish that the shared assumptions of those models are correct.*

Proposition 24.52 is important because a family of models can reproduce the same blind spot. Several analyses can rely on the same administrative categories, the same boundary convention, or the same assumption that unobserved relations are negligible. Robustness should therefore be evaluated both within a model family and against alternatives that challenge its shared structure where those alternatives are substantively plausible.

24.3.7 Inverse Problems

The epistemic architecture of GRE repeatedly generates inverse problems. Inquiry commonly begins with observed outcomes, traces, records, classifications, interactions, or manifestations and asks which relational configuration or historical trajectory could have generated them. Even perfectly recorded evidence can remain compatible with several different underlying relations. The limitation is therefore underdetermination of reconstruction rather than measurement error alone.

An inverse problem should be stated in terms of a compatibility class. The relevant epistemic object is not always one reconstructed relation, but the set of reconstruc-

tions still admissible after the available evidence and defensible assumptions have been applied. Evidence can improve knowledge by shrinking that class, separating families of explanations, identifying common structure, or ruling out mechanisms even when unique inversion remains unavailable.

Definition 24.53 (Reconstruction compatibility class). A *reconstruction compatibility class* is the set of relational configurations or historical trajectories that remain substantively compatible with a specified evidential record under the assumptions and inferential bridges adopted by an inquiry.

The compatibility class in Definition 24.53 should remain tied to the claim and to the inquiry's assumptions. Adding an archival source, changing a boundary, relaxing a behavioral assumption, or incorporating testimony can change the class. The goal is therefore not to calculate one universal set of possibilities, but to make visible how evidential and theoretical choices constrain the surviving explanations.

Definition 24.54 (Discriminating evidence). *Discriminating evidence* is evidence whose expected pattern differs materially across two or more serious candidate reconstructions and can therefore reduce the reconstruction compatibility class.

Discriminating evidence can be historical, qualitative, institutional, quantitative, experimental, or formal. A contractual clause can distinguish authorized dependence from informal convention; timing can distinguish imitation from common shock; an intervention can separate capacity from routine non-use; testimony can reveal meaning absent from transaction logs; a newly opened archive can rule out an assumed causal sequence. Methodological pluralism is therefore especially useful in inverse problems because different methods can supply different discriminating traces.

Proposition 24.55 (Inference from reconstruction invariants). *When several serious reconstructions remain admissible, GRE may warrant claims about relational properties shared across those reconstructions more strongly than claims selecting one complete reconstruction.*

This proposition supplies a disciplined alternative to forced uniqueness. If every plausible account of an institutional failure contains concentrated control over one conversion interface, the concentration claim can be robust even when the exact historical mechanism remains disputed. Such partial invariants can support explanation and intervention while preserving uncertainty about the fuller relational history.

24.3.8 Limits of Reconstruction

Some epistemic losses are recoverable through additional evidence, better access, new methods, or later disclosure. Others may be permanent. Records were never created; participants are unavailable; meanings were tacit; institutional categories erased distinctions; material traces disappeared; or several historical sequences remain observationally equivalent after every surviving source has been examined. GRE therefore requires a concept of bounded reconstruction that treats irrecoverability as theoretical content rather than as an embarrassment to be hidden by narrative completeness.

Definition 24.56 (Reconstruction adequacy profile). A *reconstruction adequacy profile* states, for a specified claim, which actors, relations, mechanisms, temporal se-

quences, contexts, and counterfactual alternatives are well supported, weakly supported, unresolved, or probably irrecoverable, together with the inferential consequences of each status.

Adequacy is therefore task-relative. A reconstruction can be inadequate for attributing responsibility to one actor while adequate for identifying the institutional structure that made a class of outcomes possible. It can be inadequate for estimating the exact magnitude of a generative effect while adequate for establishing that one conversion pathway existed. It can be inadequate for recovering subjective meaning while adequate for reconstructing formal authority. The strongest defensible claim should track the dimension that is actually recoverable.

Definition 24.57 (Irrecoverable epistemic remainder). An *irrecoverable epistemic remainder* is a materially relevant aspect of a relational target for which the surviving evidence and realistically available future evidence do not presently permit a warranted reconstruction at the resolution required by the desired claim.

Calling a remainder irrecoverable should itself be cautious. Archives can open, technologies can improve, participants can disclose new material, and apparently lost traces can be rediscovered. The designation is therefore indexed to presently realistic access conditions rather than asserted as metaphysical impossibility. Its analytical purpose is to prevent current gaps from being filled silently by theoretical preference.

Proposition 24.58 (Bounded reconstruction). *GRE can support strong relational and generative claims without complete reconstruction when the claim is confined to properties warranted across the recoverable evidence and plausible reconstruction range, and when materially unresolved dimensions remain explicit.*

Bounded reconstruction prevents two opposite errors. One is epistemic maximalism, in which a coherent narrative is mistaken for uniquely recovered history. The other is generalized skepticism, in which non-unique reconstruction is treated as preventing useful knowledge altogether. GRE can occupy the middle position by identifying robust structure, reporting unresolved alternatives, and calibrating the granularity of its conclusions.

Definition 24.59 (Epistemic revision trigger). An *epistemic revision trigger* is new evidence, access, methodological criticism, model comparison, historical recontextualization, or demonstrated observer effect that materially changes the observation-coverage profile, reconstruction compatibility class, or warranted confidence of a GRE claim.

The revision trigger connects epistemic limits to the open research programme. A newly available archive can contract a compatibility class. Discovery of shared data provenance can weaken apparent triangulation. A rival model can reveal specification dependence. Evidence of observer effects can reclassify an apparent pre-existing relation as partly intervention-generated. Newly recognized historical categories can change the interpretation of older measurements. These developments should propagate into the claims that depended on the earlier epistemic state rather than remain isolated methodological footnotes.

The epistemic limits developed in this section therefore concern the architecture of warranted access. Observation can be partial and asymmetrically distributed; re-

lations can be latent or hidden; historical actors and later researchers can occupy different epistemic horizons; observers can participate in producing the evidence they analyze; conclusions can depend on model architecture; inverse problems can admit multiple viable reconstructions; and some aspects of relational history can remain unresolved after responsible inquiry. None of these conditions entails generalized skepticism. They specify where GRE should lower claim strength, preserve alternatives, search for discriminating evidence, or state an irrecoverable remainder. The next section turns to a closely related but distinct problem: manifestations and representations can themselves distort, compress, classify, and recursively alter the relational realities through which evidence becomes available.

24.4 Manifestation and Representation Limits

Section 24.3 treated epistemic limits as limits of access, evidence, model dependence, and reconstruction. The present section examines a related but distinct source of difficulty: the processes through which relational differences become manifest and the representational forms through which those manifestations are subsequently encoded, classified, measured, narrated, modeled, or symbolized. Its objective is to identify limitations introduced by manifestation and representation themselves rather than by incomplete observation alone. The discussion returns critically to the manifestation architecture of Chapters 4–5 and asks how non-invertibility, manifestational equivalence, representation error, performative uptake, symbolic overreach, classification effects, changing manifestation relations, and reverse inference constrain GRE claims. The method is reconstructive and failure-sensitive. Existing concepts are retained where they remain adequate, but their limitations are made explicit and connected to the limitation grammar of Section 24.1.

Manifestation and representation should remain analytically distinct. Chapter 4 defined manifestation broadly as the process through which a difference becomes sufficiently differentiated and available within a manifestational configuration. Representation is narrower: it organizes selected manifestations into symbolic, linguistic, administrative, legal, statistical, computational, visual, or other forms that can stand for, classify, compare, preserve, or operationalize a target. A manifestation can therefore occur without a representation, while a representation ordinarily depends on some prior or concurrent manifestational availability. Both layers can alter what later becomes knowable and actionable.

Definition 24.60 (Mediation limit). A *manifestation-representation limit* is a condition under which the processes that render a relational difference manifest or the representations constructed from those manifestations omit, compress, transform, conflate, stabilize, amplify, or recursively alter target-relevant structure in ways that restrict warranted inference or change the relational system being analyzed.

Definition 24.60 contains two families of limitation. The first concerns the manifestation relation itself: several relational configurations can become manifest in similar forms, one configuration can manifest differently under different conditions, and the mapping can change historically. The second concerns representation: symbolic forms can introduce target-relative error, acquire unwarranted semantic authority,

Table 24.4: Manifestation and representation limits in GRE inquiry.

Limit	Core problem	Required discipline
Non-invertibility	Manifest form does not uniquely recover antecedent relational structure	Retain compatible antecedents and seek discriminating evidence
Manifestational equivalence	Relationally different configurations are indistinguishable under an operative manifestation regime	State the equivalence criterion and the distinctions it suppresses
Representation error	Encoding or interpretation fails to preserve target-relevant structure	Evaluate error relative to target, use, scale, and representational genealogy
Performative representation	Uptake of a representation changes the system it purports to describe	Separate descriptive adequacy from causal efficacy and trace feedback
Symbolic overreach	Symbolic precision or authority exceeds warranted target correspondence	Match semantic strength to the evidence connecting symbol and target
Classification effects	Categories alter eligibility, recognition, behavior, or later data generation	Treat consequential classification as both representation and intervention
Changing manifestation relations	The rule linking target and manifestation changes over time or context	Reconstruct mapping change before interpreting manifest change as target change
Reverse-inference limit	Available manifestations and representations support only bounded reconstruction	State the strongest invariant claim and preserve unresolved alternatives

classify cases consequentially, or become performative through institutional uptake. These families interact, but neither should be reduced to the other.

Table 24.4 summarizes the principal limitations developed below.

24.4.1 Non-Invertibility

Chapter 4 established manifestational non-invertibility as a local property of an inquiry: an available manifestation need not support unique and warranted recovery of the antecedent relational configuration at the scale required by the question. The present limitation is not merely that information is missing. Manifestation itself can compress, aggregate, classify, normalize, or reorganize differences so that distinct antecedents become compatible with the same manifest form. Additional observation can improve inference without necessarily restoring what the manifestation process has already erased.

A precise market price, administrative score, legal status, institutional category, behavioral regularity, or statistical indicator can therefore be highly determinate as a manifestation while remaining underdeterminate as evidence of generative history. The distinction matters because standardized forms often invite reverse inference. A wage may be interpreted as revealing productivity, a test score as revealing learning, a price as revealing value, a formal title as revealing practical authority, or an

observed choice as revealing stable preference. GRE should instead ask which relational configurations remain compatible with the manifested form under the operative mapping conditions.

Definition 24.61 (Inversion-adequacy profile). An *inversion-adequacy profile* records the manifestation used for reverse inference, the manifestation relation believed to have generated it, the materially distinct antecedent configurations that remain compatible with the manifestation, the evidence available for discriminating among them, and the resolution at which reconstruction becomes warranted or remains non-unique.

The profile prevents a binary understanding of invertibility. Reverse inference can be adequate for one property and inadequate for another. A registry entry may uniquely establish a legally recorded status while leaving practical dependence, social recognition, bargaining history, or subjective meaning unresolved. A measured output may identify that a process occurred while failing to identify which mechanism produced it. The relevant question is therefore not whether a manifestation has an inverse in the abstract, but which target properties can be recovered with what warrant.

Proposition 24.62 (Non-invertibility floor). *When materially different antecedent relational configurations remain compatible with the available manifestations after serious use of accessible discriminating evidence, GRE should not infer a more specific antecedent than the properties shared across the remaining compatibility class.*

Proposition 24.62 is a restraint on explanatory granularity. It does not prohibit causal interpretation. It requires the causal claim to stop at the level warranted across serious alternatives. Where several histories all contain concentrated gatekeeping but differ in whether that gatekeeping arose through law, organizational convention, technical architecture, or strategic coordination, the concentration may be well supported while the precise historical mechanism remains open.

24.4.2 Manifestational Equivalence

Non-invertibility becomes particularly important when an operative manifestation regime treats relationally distinct configurations as equivalent. Equality at the level of manifestation can arise because the regime deliberately ignores certain distinctions, because its resolution is insufficient to register them, or because different histories converge on forms that satisfy the same classificatory or observational criterion. The resulting equivalence is always indexed to a manifestation regime and an analytical purpose.

Definition 24.63 (Claim-relative manifestational equivalence). Two relational configurations are *claim-relatively manifestationally equivalent* when the operative manifestation regime renders them indistinguishable with respect to the manifested properties used by a specified claim, even though the configurations differ in one or more relational properties outside that manifestational criterion.

This definition avoids treating equivalence as identity. Two households can have the same measured income while differing sharply in debt, care obligations, security, informal support, legal status, or exposure to risk. Two organizations can report

the same productivity indicator while relying on different labor processes. Two students can receive the same score through different learning trajectories. Two political economies can produce the same aggregate growth rate while distributing capabilities and vulnerabilities very differently. The manifestation regime can legitimately treat such cases as equivalent for one narrow purpose without authorizing equivalence for another.

Definition 24.64 (Suppressed-difference register). A *suppressed-difference register* identifies relational distinctions that are intentionally or unintentionally treated as equivalent by a manifestation regime and records which GRE claims would become invalid or incomplete if those suppressed differences proved materially consequential.

The register makes manifestational equivalence auditable. It is especially useful where policy, administration, markets, or research systems depend on standardized categories. Standardization can enable coordination and comparison, yet the same standardization can erase differences relevant to justice, generativity, vulnerability, or causal mechanism. GRE need not reject standardized manifestations. It should specify what the standard preserves and what it makes unavailable.

Proposition 24.65 (Equivalence-scope discipline). *Manifestational equivalence warrants substitution between cases only for claims whose target-relevant distinctions are preserved by the operative equivalence criterion.*

The proposition prevents a common inferential expansion in which equivalence established for measurement or administration becomes equivalence for explanation, value, responsibility, or intervention. A shared category can support aggregation without supporting identical treatment in every downstream domain.

24.4.3 Representation Error

Chapter 5 defined representation error as a target-relative discrepancy introduced when a representation omits, distorts, conflates, misclassifies, mis-scales, or otherwise preserves inadequately a feature material to the claim for which the representation is used. The present section treats that definition as an internal limitation of GRE because GRE itself depends heavily on relational maps, histories, categories, tables, formal structures, models, diagrams, indicators, and narratives. Representational failure can therefore arise not only in the economic systems GRE studies but also in GRE's own research practice.

Several distinctions deserve preservation. Selection error concerns which relations or cases enter the representation. Classification error concerns how they are grouped. Aggregation error concerns structure lost through combination. Semantic error concerns a mismatch between symbol and interpreted relation. Temporal error concerns treating a representation as current after its target has changed. Structural error concerns imposing a representational form that does not preserve the relevant organization, such as forcing a higher-order or temporally evolving relation into a static pairwise graph.

Definition 24.66 (Representation-error profile). A *representation-error profile* records the target, representational purpose, encoding rules, preserved features,

omitted features, plausible error modes, error genealogy, sensitivity of the substantive claim to those errors, and available routes of correction or alternative representation.

The genealogy component is important because apparently independent representations can inherit the same upstream categories or records. Several datasets can agree because each reproduces one administrative classification. Several models can appear robust because each uses the same proxy. Several historical accounts can converge because they draw from the same archive created under one institutional visibility regime. Agreement among representations should therefore be evaluated partly by the independence of their representational histories.

Proposition 24.67 (Correlated representation-error condition). *Agreement among several representations provides weaker corroboration when their target-relevant errors are plausibly correlated through shared categories, data-generating processes, institutional procedures, or inherited representational assumptions.*

This condition connects representation limits with the triangulation discipline of Chapter 5. Heterogeneous methods are valuable not merely because there are several of them, but because they can fail differently. A qualitative account, administrative record, legal document, network representation, and historical archive can strengthen one another when they provide partially independent access to the relevant structure. Multiplication of representations derived from one upstream schema does not create the same epistemic gain.

Representation error should also be propagated rather than quarantined. If a value-conversion claim depends on a classification that later proves too coarse, or a power claim depends on an indicator whose semantics have shifted, the downstream claim should be reconsidered. This is one reason the versioned research infrastructure developed in Chapter 22 matters: correction requires knowledge of which conclusions depended on which representational state.

24.4.4 Performative Representation

Representations can exceed the role of passive description. A score can affect eligibility; a forecast can alter investment; a ranking can redirect attention; a legal representation can change rights and duties; a risk category can alter monitoring; a model output can influence policy; an AI-generated summary can shape expectations. When uptake of the representation changes later relations, the representation becomes part of the generative-relational system it helps describe.

This performativity creates a distinctive limitation because descriptive adequacy and causal efficacy can diverge. A representation can be inaccurate yet consequential. Once institutions act on it, later observations may partly reflect the representation's effects rather than the antecedent structure the representation originally purported to track. A prediction can help produce the outcome later treated as confirmation. A category can organize behavior around its boundaries. A metric can redirect effort toward measured dimensions and away from unmeasured ones.

Definition 24.68 (Representational uptake pathway). *A representational uptake pathway records the representation, the positions or institutions that encounter it, the au-*

thority or practical standing attributed to it, the decisions or actions conditioned by that uptake, and the subsequent relational changes through which the representation becomes causally consequential.

The pathway distinguishes circulation from effect. A representation can be widely visible yet practically ignored. Another can be encountered by few actors but possess decisive authority at a gatekeeping point. The relevant variable is not exposure alone but the relation between representation, standing, decision, and subsequent configuration.

Definition 24.69 (Reflexive representational loop). *A reflexive representational loop occurs when a representation affects later relational conditions in ways that materially alter the manifestations or data subsequently used to evaluate, reproduce, or revise that representation or a related representational scheme.*

Reflexive loops complicate validation. If a credit category restricts access and later low asset accumulation is used to validate the category, the observed association can contain effects produced by prior classification. If a ranking directs attention and later attention is treated as evidence of rank quality, the evaluation is partly endogenous to the ranking. GRE should therefore reconstruct whether the evidence used for validation was generated before, independently of, or partly through uptake of the representation.

Proposition 24.70 (Performativity does not validate representation). *The causal efficacy, institutional persistence, or self-reinforcing reproduction of a representation does not by itself establish the representation's epistemic adequacy, normative desirability, or ontological correctness.*

This proposition restates, as a limitation principle, the recursive architecture of Chapter 4. A representation can become relationally real because it is persistently used and causally efficacious while remaining a poor account of the antecedent target. GRE must therefore be able to analyze the reality of a representation's effects without endorsing the representation's truth or legitimacy.

24.4.5 Symbolic Overreach

Symbolic systems enable memory, comparison, formalization, communication, and cumulative inquiry. They also create a recurring temptation: the determinacy of the symbol can be mistaken for determinacy of the target. Exact numerical values, sharply bounded categories, formal notation, legal terminology, diagrams, model parameters, and computational outputs can appear more settled than the manifestation and relational structures they represent.

Definition 24.71 (Symbolic overreach). *Symbolic overreach occurs when the precision, granularity, stability, scope, inferential authority, or ontological implication attributed to a symbol or symbolic system exceeds the warrant supplied by the manifestation and representation relations connecting that symbol to its target.*

Symbolic overreach can be quantitative or qualitative. Reporting a coefficient to several decimal places can overstate measurement stability. Assigning a sharply defined category can overstate the clarity of a boundary. Using a mathematical object can suggest stronger structural correspondence than has been demonstrated. A legal

or administrative label can be treated as if it exhausted practical identity. A graph can suggest discrete nodes and edges where the empirical phenomenon is distributed, higher-order, contested, or temporally unstable. The issue is not the use of symbols. It is the transfer of symbolic properties to the target without an adequate bridge.

Definition 24.72 (Symbolic-determinacy gap). A *symbolic-determinacy gap* is the difference between the degree of determinacy encoded or displayed by a representation and the degree of target-level determinacy warranted by the evidence, manifestation relation, and representational semantics available for the relevant claim.

The gap provides a useful diagnostic for formal GRE. A formal model can be exactly specified while its empirical objects remain partly identified. This is not necessarily a defect: exact formal structure can clarify assumptions and consequences. The limitation arises when formal exactness is cited as evidence that the world shares the same exactness. A later section will examine formalization limits directly; the present point concerns the representational bridge on which those formalisms depend.

Proposition 24.73 (Semantic-strength constraint). *The semantic and inferential strength assigned to a GRE symbol should not exceed the strongest target correspondence that has been independently justified for the inquiry in which the symbol is used.*

This constraint protects notation from becoming a substitute for argument. A symbol can remain useful under weaker semantics. A variable can be explicitly operational rather than ontological; a network edge can represent documented interaction rather than an exhaustive relation; an amplitude-like object can remain a formal analogy rather than an empirically identified physical quantity. Making the semantics weaker and clearer can improve rather than diminish the analysis.

24.4.6 Classification Effects

Classification is a particularly important case because it can occupy several analytical roles at once. A category can describe an already manifest difference, compress several differences for administrative use, determine eligibility, distribute recognition, guide intervention, alter self-understanding, or shape the production of later records. Classification can therefore be simultaneously representational, institutional, and generative.

A classification error and a classification effect should remain distinct. A case can be correctly assigned according to an operative rule while the rule itself produces consequential effects. Conversely, a category can be epistemically poor while its institutional enforcement remains powerful. GRE needs to analyze both the adequacy of the classification and the relations generated through its use.

Definition 24.74 (Classification-effect profile). A *classification-effect profile* records the category system, classificatory rule, authority of application, represented target, positions classified, consequences of assignment, available contest routes, behavioral or institutional responses, effects on later data generation, and conditions under which the classification can be revised or exited.

The profile makes classification temporally recursive. A category applied at one moment can change access, incentives, visibility, expectations, or organizational

treatment. Those changes can alter the later characteristics observed in the classified population. If the later characteristics are then used to justify the classification without accounting for the intervention, the representational and causal roles become circular.

Proposition 24.75 (Classification-intervention condition). *When assignment to a category materially changes a classified position's feasible actions, recognition, resources, obligations, exposure, or future manifestations, the classification should be analyzed as an intervention in addition to being evaluated as a representation.*

This condition is relevant to economic categories, educational tracks, credit ratings, labor classifications, risk scores, legal statuses, welfare eligibility, organizational performance groups, and many other settings. It does not imply that consequential classification is illegitimate. It requires the inquiry to include the downstream effects of classification in the object of analysis.

Classification can also affect what becomes visible. Institutions often collect different information after a case enters a category. Monitoring may intensify for one group and weaken for another. Record systems can add fields for recognized categories while leaving unrecognized experiences unrecorded. Classification effects therefore reach back into epistemology by reshaping the manifestation regime through which later evidence is generated.

24.4.7 Changing Manifestation Relations

A manifestation relation need not remain fixed while the target changes. Measurement technologies evolve, administrative categories are revised, legal thresholds shift, reporting incentives change, institutional coverage expands, actors learn to respond strategically, cultural meanings change, and computational systems are updated. The same observed label or numerical series can therefore be generated by different manifestation relations at different times.

Chapter 5 already emphasized that observed change can reflect change in the relational target, change in the manifestation relation, or interaction between both. The limitation becomes especially serious for longitudinal GRE because historical analysis often relies on records whose apparent continuity exceeds the continuity of the conditions under which they were produced.

Definition 24.76 (Manifestation-regime drift). *Manifestation-regime drift* is a change over time or across contexts in the rules, mediators, thresholds, technologies, incentives, categories, institutional procedures, or scope through which a relational target becomes manifest, such that nominally similar manifestations no longer preserve the same target-relevant relation.

Drift can be gradual or discontinuous. A survey question can retain the same wording while its social meaning changes. A statistical category can preserve its label after eligibility rules are altered. A platform metric can remain visible while the ranking algorithm beneath it changes. A legal status can acquire new practical consequences without a change in terminology. A historical archive can appear continuous while the institutional population entering the archive changes.

Definition 24.77 (Longitudinal manifestation-comparability profile). *A longitudinal*

manifestation-comparability profile records the periods or contexts being compared, the manifestation relations operating in each, known changes in rules or implementation, plausible strategic responses, preserved and non-preserved semantics, and the level of comparison that remains warranted after those changes are considered.

The profile can support several outcomes. Some changes can be recalibrated through overlapping measurements or conversion rules. Some permit only coarse comparison. Others create a genuine break after which one continuous series should not be interpreted as a single unchanged variable. Documented non-comparability is itself a valid result.

Proposition 24.78 (Mapping-change attribution discipline). *GRE should attribute change to a relational target only to the extent that serious alternatives involving change in the manifestation relation have been excluded, bounded, or incorporated into the claim at the resolution required by the inquiry.*

The discipline is particularly important where institutions respond to measurement. A change in reported behavior can arise because the behavior changed, because the reporting rule changed, because incentives to report changed, because classification changed, or because actors adapted to the measurement regime. Historical and comparative inference should therefore treat the manifestation mapping as a possible moving component of the system.

24.4.8 Limits of Reverse Inference

The preceding limits converge on reverse inference. GRE frequently begins with manifestations and representations: prices, records, scores, legal statuses, interviews, archives, classifications, measurements, network traces, model outputs, narratives, or institutional decisions. The analytical task is to infer something about relational structure, generative mechanism, historical trajectory, value conversion, power, dependence, or future possibility. Reverse inference is unavoidable. The limitation lies in treating its result as stronger or more unique than the manifestation and representation architecture permits.

Reverse inference becomes especially fragile when several limitations combine. A manifestation can be non-invertible; the operative representation can contain systematic error; the classification can change later behavior; the manifestation regime can drift; and the symbolic form can display more precision than the target warrants. These are not independent technical nuisances. Their interaction can create a reconstruction that is internally coherent and institutionally persuasive while remaining weakly connected to the antecedent relational reality.

Definition 24.79 (Reverse-inference dossier). A *reverse-inference dossier* records the target claim, manifestations used, representations constructed from them, relevant manifestation relations, known non-invertibilities and equivalences, representation-error profiles, performative or classificatory feedback, manifestation-regime changes, serious antecedent alternatives, discriminating evidence, and the strongest claim that remains invariant across those considerations.

The dossier integrates rather than replaces the epistemic profiles of Section 24.3. Observation coverage asks which evidence is available. The reverse-inference

dossier asks what transformations the available evidence has already undergone and what causal effects those representational forms may have produced. The two inquiries are complementary. Better access does not solve a poor manifestation mapping, while an excellent representation cannot compensate for evidence that never existed or remains inaccessible.

Definition 24.80 (Bounded reverse inference). *Bounded reverse inference* is inference from manifestations or representations to relational properties that remain warranted across the serious manifestation mappings, representational uncertainties, feedback pathways, and antecedent configurations compatible with the available evidence, while leaving stronger non-invariant properties unresolved.

Bounded reverse inference parallels bounded reconstruction in Proposition 24.58. The distinction is that the present concept makes the mediating role of manifestation and representation explicit. A price series may support a robust claim about persistent volatility while leaving the underlying composition of expectations unresolved. A legal record may support a claim about recognized status while leaving practical authority unresolved. A classification history may support a claim about institutional treatment while leaving the represented personal or social identity contested.

Proposition 24.81 (Reverse-inference restraint). *A GRE claim inferred from manifestations or representations should be no more specific than the target-relevant properties that remain stable after plausible non-invertibility, representation error, performative feedback, classification effects, and manifestation-regime change have been taken into account.*

This proposition does not demand exhaustive skepticism before every empirical claim. It demands proportional scrutiny. A narrow, directly institutional claim may require little reconstruction. A strong claim about latent power, long-run generativity, historical mechanism, or relational ontology requires more. The relevant burden increases with inferential distance between manifest evidence and the target claim.

Definition 24.82 (Manifestation-representation revision trigger). *A manifestation-representation revision trigger* is evidence that materially changes the understood mapping between relational target, manifestation, representation, or representational uptake in a way that alters the warrant, interpretation, comparability, or causal status of a GRE claim.

Examples include discovery that a statistical series changed definition, evidence that an apparently descriptive category altered the behavior later used to validate it, recognition that several data sources inherited the same coding error, demonstration that a formal symbol was being interpreted more strongly than its empirical semantics permit, or recovery of an alternative manifestation that distinguishes previously equivalent antecedents. Such evidence should propagate through downstream conclusions whose warrant depended on the earlier representational state.

Manifestation and representation limits therefore arise neither because appearances are unreal nor because symbolic mediation is inherently unreliable. Manifestations are real events or states of availability, and representations can be indispensable instruments of inquiry, coordination, memory, and institutional action. Their limitation is structural: manifestation can be non-invertible; different relational configurations can become manifestationally equivalent; representations

can introduce target-relative error; representation can become performative; symbolic determinacy can exceed target warrant; classification can change the objects and evidence to which it is later applied; and manifestation relations can drift historically. GRE remains possible under these conditions by treating mappings, representations, and their feedback effects as explicit objects of analysis and by bounding reverse inference to what those objects actually support. The next section turns to limits that arise within relational analysis itself, including boundary and scale dependence, relation identification, persistence, higher-order complexity, field reconstruction, missingness, and the limits of relational reduction.

24.5 Relational Limits

Relational analysis is one of the principal methodological commitments of GRE, but a commitment to relations does not remove the need to specify how relations are delimited, typed, compared, aggregated, and distinguished from the objects and processes they connect. Chapters 4–8 developed relational reality, boundary and scale, relation identity, higher-order relations, fields, relational methods, and generative attribution as constructive resources. The present section returns to those resources critically. Its role is to identify limits that arise *within relational analysis itself*, after ontological suspension, epistemic access, manifestation, and representation have already been treated separately. The objective is to clarify when a relational explanation depends materially on boundary or scale, when the relation being analyzed is insufficiently identified, when continuity claims exceed the evidence, when higher-order or field language outruns reconstruction, when missing relations reorganize the apparent structure, and when relational vocabulary ceases to discriminate among rival explanations. The section proceeds through boundary dependence, scale dependence, relation identification, relation persistence, higher-order complexity, field reconstruction, missingness, and the limits of relational reduction. Its method is sensitivity-oriented and comparative: a relational claim is tested by varying plausible boundaries, scales, relation definitions, continuity rules, structural orders, and alternative non-relational or mixed explanations while asking which conclusions remain stable.

These limits should not be confused with the epistemic limitations of Section 24.3. A researcher may possess excellent evidence for every observed interaction and still obtain a boundary-dependent network. A relation may be clearly manifested and represented while changing meaning across scale. A complete transaction record may still fail to establish whether repeated transactions constitute dependence, trust, hierarchy, or only recurrent exchange. The problem is therefore not always lack of evidence. It can arise from the architecture of relational description itself.

Definition 24.83 (Relational-analysis limitation). A *relational-analysis limitation* is a condition under which the identification, interpretation, persistence, aggregation, configuration, or explanatory role of a relation depends materially on analytical choices or unresolved structural features such that the resulting GRE claim cannot be transported unchanged across plausible boundaries, scales, relation specifications, temporal criteria, or explanatory decompositions.

Definition 24.83 does not make relational inquiry arbitrary. It requires the depen-

Table 24.5: Relational limits and corresponding GRE responses

Relational object	Characteristic limitation	Required response
Boundary	Material relations cross or constitute the analytical perimeter.	Report boundary logic and test plausible alternatives.
Scale	Relational properties change under aggregation, disaggregation, or cross-level coupling.	State scale and examine scale sensitivity.
Relation type	Observed interaction underdetermines relational meaning or mechanism.	Define endpoints, semantics, direction, temporality, and evidential criteria.
Persistence	Continuity can be asserted despite transformation in participants, rules, or function.	State the continuity criterion and identify discontinuities.
Higher order	Pairwise projections can erase collective or relation-among-relation structure.	Preserve only higher-order structure warranted by the target and evidence.
Field	Distributed conditioning can become a residual label for unexplained context.	Reconstruct positions, boundaries, mechanisms, and rivals.
Missingness	Unobserved relations can alter inferred positions and configurations.	Model missingness relationally and test sensitivity to plausible unseen structure.
Reduction	Relational vocabulary can absorb materially distinct mechanisms without discrimination.	Retain mixed or domain-specific explanatory components where needed.

dency to be made inspectable. Some relational claims remain remarkably stable across alternative specifications; others are informative precisely because their instability reveals where the relevant organization changes. The critical mistake is to treat a specification-dependent relational result as though it were specification-free.

Table 24.5 summarizes the principal relational limits developed in this section.

The eight limits are coupled. A boundary decision changes which relations can be missing; a scale decision changes which relations can be identified as persistent; a pairwise representation can create an apparent field whose higher-order organization has been suppressed; and an expansive relational vocabulary can make every omitted mechanism appear relational by definition. GRE therefore needs not only richer relational descriptions but also disciplined stopping rules concerning what relational description can legitimately establish.

24.5.1 Boundary Dependence

Every relational analysis requires a provisional answer to the question of what belongs inside the object of inquiry. Chapter 5 treated boundary selection as an epistemic condition of relational knowledge. The present limitation is stronger: some conclusions change materially when a plausible boundary changes even if evidence within each candidate boundary is excellent. A relation classified as external under one specification can become constitutive under another; a seemingly autonomous organization can become dependent when financing, infrastructure, household reproduction, regulation, ecological input, or platform access is brought inside the an-

alytical frame.

Boundary dependence matters especially where GRE studies generativity. An intervention can appear generative inside a beneficiary organization while displacing costs into households or suppliers outside the organizational boundary. A market can appear competitive within a product boundary while depending on an upstream bottleneck excluded from that definition. A local institution can appear resilient when the analysis omits external fiscal or infrastructural support that enables the observed stability. None of these examples makes the narrower boundary illegitimate. They make the reach of the conclusion conditional on it.

Definition 24.84 (Relational boundary-sensitivity profile). A *relational boundary-sensitivity profile* records the target claim, the operative boundary rule, materially plausible alternative boundaries, relations or conditions added or removed under those alternatives, and the aspects of the relational conclusion that remain stable, weaken, reverse, or become indeterminate when the boundary changes.

The profile separates a robust local result from a robust system-level result. If a claim survives several substantively plausible boundaries, confidence in its portability can increase. If it changes, the change is not merely a defect. It can identify the interface through which the supposedly external environment participates in constituting the focal process.

A second boundary problem concerns institutionalized boundaries. Legal incorporation, administrative eligibility, statistical categories, organizational membership, property lines, and jurisdictional borders can themselves organize relations. In such cases a boundary is both an analytical choice and an object with relational reality. Sensitivity analysis should not erase that distinction. The question is whether the inquiry is varying an observer-imposed perimeter, describing an enacted boundary, or examining the relation between both.

Proposition 24.85 (Boundary-conditioned relational warrant). A *GRE relational claim whose interpretation or explanatory force changes materially under substantively plausible boundary specifications should be stated as boundary-conditioned unless independent evidence justifies privileging one boundary for the target claim.*

Proposition 24.85 prevents local tractability from being mistaken for natural closure. It also provides a constructive research strategy: cases of high boundary sensitivity identify where further inquiry into external or interface relations is most likely to alter the explanation.

24.5.2 Scale Dependence

Scale creates a related but distinct limitation. Boundary asks what is included; scale asks at what level of organization relational differences are represented. A household relation can be described at the level of individuals, roles, household units, kinship networks, neighborhoods, or intergenerational transfer systems. A firm can be represented through persons, teams, divisions, legal entities, supply networks, sectors, or wider infrastructures. The relation identified at one scale need not preserve its meaning, direction, or explanatory role after aggregation or disaggregation.

Scale dependence can arise through several mechanisms. Aggregation can erase

heterogeneity among lower-level relations. Disaggregation can dissolve an emergent relation that exists only among collective units. A local asymmetry can cancel at a higher level, while individually weak relations can aggregate into a strong institutional constraint. Cross-scale feedback can make a relation simultaneously an effect at one scale and a condition at another. GRE therefore should not presume that a relational property travels vertically without transformation.

Definition 24.86 (Relational scale profile). A *relational scale profile* records the units and relation types represented at each analytically relevant scale, the aggregation or disaggregation rule connecting those scales, cross-scale couplings, and the relational properties that are preserved, transformed, newly generated, or lost under movement between them.

The profile makes explicit that scale is not merely a matter of spatial size. Organizational, temporal, institutional, network, and value scales can differ. A relation persistent at a weekly observational scale can disappear at a daily scale and change meaning at a generational one. A formal rule can operate nationally while its enactment is locally heterogeneous. A platform can be centralized technically while economic dependence is distributed unevenly across users and sectors.

Definition 24.87 (Scale-induced relational reclassification). *Scale-induced relational reclassification* occurs when a relation legitimately identified at one scale must be assigned a different type, direction, strength, or explanatory role at another scale because the units, aggregation rule, or cross-scale organization changes the property being represented.

Reclassification is not necessarily inconsistency. It can be a substantive property of multiscale organization. The limitation arises when a claim at one scale is generalized to another without reconstructing the bridge. The multiscale analyses developed elsewhere in this book therefore require explicit scale semantics rather than merely multiple resolutions of the same variable.

Proposition 24.88 (Cross-scale transport condition). *A relational conclusion should be transported across scales only when the inquiry specifies how the relevant relation semantics, and explanatory role are preserved or transformed by the scale transition at the resolution required by the claim.*

This condition permits both invariance and transformation. Some relations may remain substantively stable across scales; others may acquire new meaning. The burden is to identify which case applies rather than assuming either universal scale invariance or universal scale relativity.

24.5.3 Relation Identification

A relational framework can become deceptively precise when the existence of an observed connection is treated as sufficient identification of the relation itself. Transactions, communications, co-presence, legal ties, citations, shared membership, physical proximity, data flows, or repeated interactions are observable structures, but each can support several relational interpretations. Repeated communication need not establish trust; ownership need not establish effective control; co-membership need not establish cooperation; price correlation need not establish direct dependence; a

formal contract need not exhaust the enacted employment relation.

Relation identification therefore requires more than endpoints. The inquiry should specify what the relation means in the domain, whether it is directed or symmetric, binary or graded, episodic or continuous, formal or informal, exclusive or multiplex, observed or inferred, and which evidence would distinguish it from nearby relation types. Where these dimensions remain unresolved, a relational graph or formal object can encode more semantic certainty than the evidence supports.

Definition 24.89 (Relation-identification dossier). *A relation-identification dossier records the candidate relation type, relata and their identity criteria, direction and multiplicity where relevant, domain semantics, temporal support, institutional status, observable traces, inferential bridge from trace to relation, plausible rival relation types, and the evidence capable of discriminating among them.*

The dossier is especially important for relations that carry strong explanatory or normative implications. Dependence, authority, domination, trust, obligation, exploitation, care, recognition, and power should not be inferred merely from structural proximity or repeated interaction. GRE can use structural patterns as evidence, but the semantic bridge must be independently justified.

A related problem is multiplexity. The same pair of relata can simultaneously be connected through employment, kinship, debt, friendship, legal authority, information exchange, or shared institutional membership. Compressing these into a single edge can obscure which relation generates the observed effect and how different relation types reinforce or counteract one another.

Definition 24.90 (Relational semantic ambiguity). *Relational semantic ambiguity is the condition in which the available evidence supports the existence of interaction or connection while remaining compatible with materially different interpretations of the relation's type, meaning, mechanism, or normative significance.*

Ambiguity should be represented rather than hidden. An analysis can remain useful at a coarser level by claiming recurrent interaction, formal linkage, or information exchange while leaving stronger interpretations unresolved.

Proposition 24.91 (Minimum relation-identification condition). *A GRE claim that depends on a specific relation type should identify evidence for the properties that distinguish that type from serious alternatives; where such discrimination is unavailable, the claim should remain at the coarser relational level actually supported by the evidence.*

The proposition parallels the restraint on reverse inference in Section 24.4. The present issue, however, is not only that manifestations are non-invertible. It is that the analytical category “relation” can itself be underspecified unless its semantics are reconstructed.

24.5.4 Relation Persistence

Relational explanation frequently extends across time. GRE speaks of persistent dependence, institutionalized cooperation, enduring power, long-lived exchange relations, intergenerational transfer, stabilized fields, and historical trajectories. These claims require a criterion for deciding when a relation remains the same relation

through change and when a new relation has formed.

Persistence is not simple repetition. An employment relation can continue after a change of supervisor, task, wage, or location. A diplomatic relation can persist through changing governments. A credit relation can be renegotiated while preserving an underlying obligation. Conversely, repeated transactions between the same parties can constitute a sequence of separate encounters rather than one continuing relation. Identity over time therefore depends on which relational properties are treated as continuity-bearing for the target inquiry.

Definition 24.92 (Relational persistence profile). A *relational persistence profile* records the relation's proposed continuity-bearing properties, changes in relations, rules, roles, intensity, medium, meaning, and causal function, periods of interruption or dormancy, and the evidence used to classify observed variation as persistence, transformation, dissolution, or replacement.

The profile prevents historical narratives from creating continuity by vocabulary alone. The same label can cover materially different relations across periods, while a relation whose label changes can preserve important structural continuity. This is especially significant where institutional succession, legal reform, technological mediation, or organizational restructuring changes the observable form of an underlying relation.

Definition 24.93 (Relational identity threshold). A *relational identity threshold* is the stated set of continuity-bearing properties sufficient for treating temporally separated manifestations as stages of one relation for a specified analytical purpose, together with the changes that would instead require classification as a new relation.

The threshold is purpose-relative but not arbitrary. A legal inquiry may privilege continuity of authorized rights and obligations; an economic inquiry may privilege continuity of dependency or exchange; a social inquiry may privilege continuity of role or recognition. When a GRE claim depends on several of these dimensions simultaneously, one continuity criterion may be insufficient.

Proposition 24.94 (Persistence-sensitive attribution). A *temporally extended GRE attribution* should not treat relational continuity as given when changes in the relation's continuity-bearing properties are themselves capable of altering the mechanism or outcome being explained.

This condition matters for generative analysis because transformation of the relation may be the generative event. Treating the pre- and post-transformation relation as identical can erase precisely the historical change that needs explanation.

24.5.5 Higher-Order Complexity

Pairwise relations are often analytically useful, but many economic processes depend on configurations whose relevant unit is a group, a relation among relations, a rule governing other relations, or a nested and multilayer arrangement. Chapter 5 developed higher-order relational knowledge, and Chapters 7–8 introduced corresponding methodological and formal resources. The limitation is that higher-order enrichment can expand faster than the available evidence and faster than the capacity of a model to discriminate among competing configurations.

A three-party guarantee, a multilateral bargaining arrangement, a household allocation rule, a supply-chain standard, or a governance meta-rule can possess properties not preserved by decomposing it into independent dyads. Conversely, representing every possible higher-order combination can create an enormous space of candidate structures with little evidential basis. The challenge is therefore not to maximize relational order but to preserve the lowest order that still retains the target-relevant structure.

Definition 24.95 (Higher-order reconstruction burden). The *higher-order reconstruction burden* is the additional evidential and semantic warrant required when a GRE claim attributes explanatory significance to collective relations, relations among relations, nested relations, multilayer configurations, hyperrelations, or other structures not recoverable from the independently interpreted pairwise relations alone.

This burden includes evidence that the higher-order object exists as more than an analyst's convenient grouping, that its membership or components are identified, that its higher-order property matters to the target claim, and that a simpler lower-order representation would lose substantively relevant information.

Definition 24.96 (Relational projection loss). *Relational projection loss* is the target-relevant information lost when a higher-order or multilayer relational configuration is represented at a lower order, fewer layers, or a coarser relational type.

Projection loss can be diagnosed empirically or conceptually. If a pairwise projection predicts or explains the target as well as the higher-order model, the additional structure may not be needed for that claim. If the projection destroys collective eligibility rules, joint obligations, coalition constraints, or relational dependencies among ties, higher-order representation has earned its place.

Proposition 24.97 (Minimum sufficient relational order). *GRE should represent relational order no higher than required to preserve the target-relevant structure and no lower than permitted by the evidence and mechanism, with departures in either direction treated as potential sources of explanatory distortion.*

The proposition guards against two symmetric errors: dyadic reduction of genuinely collective structure and formal inflation through unnecessary higher-order objects. Complexity is not evidence of adequacy; adequacy depends on preserving the structure relevant to the research question.

24.5.6 Field Reconstruction

Field language extends relational analysis from identifiable local ties to distributed conditions in which position within a wider organization changes capacities, constraints, expectations, or the meaning of local relations. This can be indispensable when no single dyad carries the explanatory burden. It also creates a distinctive limit: "field" can become a residual term for whatever appears systemic but has not been reconstructed.

A defensible field claim requires more than a patterned outcome. Similar regularities can arise from common exposure, selection, shared institutions, synchronized response, network diffusion, correlated constraints, or genuinely distributed relational conditioning. A field explanation should therefore identify what structure is

distributed, how positions differ, what evidence supports the reconstructed organization, which boundary and scale apply, and what rival mechanisms could generate similar manifestations.

Definition 24.98 (Field-reconstruction adequacy profile). A *field-reconstruction adequacy profile* records the target phenomenon, proposed distributed organization, positional or dependency structure, boundary, scale, temporal interval, local and cross-field relations, evidence for distributed conditioning, serious rival mechanisms, and the conclusions that remain stable across plausible field specifications.

The profile also preserves ontological restraint. A successful field representation can establish that a distributed relational organization is explanatorily useful and evidentially supported without establishing that reality is fundamentally field-like. Section 24.2 already separates explanatory priority from ontological priority; field reconstruction is one concrete application of that distinction.

A second problem concerns overlapping fields. Financial, legal, professional, technological, political, educational, and cultural organizations can condition the same actor simultaneously. A result attributed to one field may depend on a cross-field conversion or coupling. GRE should therefore resist attributing residual variation to the most visible field when a multi-field explanation remains plausible.

Definition 24.99 (Field-attribution remainder). A *field-attribution remainder* is the part of a target pattern left insufficiently explained after the proposed field's distributed organization, local relations, boundary, scale, and plausible overlapping fields have been reconstructed at the resolution warranted by the evidence.

The remainder should not automatically be absorbed into a more expansive field. It can indicate omitted local mechanisms, another field, measurement or manifestation problems, stochastic variation, material constraints, or a mistaken target specification.

Proposition 24.100 (Field non-residuality condition). A *relational-field explanation* should add discriminating structure beyond the statement that outcomes are context-dependent or systemically organized; where no such structure is identified, field language should be treated as a heuristic rather than as a completed explanation.

24.5.7 Missingness

Relational missingness differs from ordinary missing values because one unobserved relation can alter the apparent positions, paths, clusters, dependencies, brokerage relations, higher-order configurations, and field boundaries of many observed elements. Chapter 7 developed missingness in relational data as a methodological problem. At the level of theoretical limitation, the key issue is that relational structure can be highly sensitive to evidence that is absent precisely because the relation is informal, concealed, unequal in observability, excluded by institutional recording, or generated outside the research boundary.

Missingness therefore has both a data dimension and a structural dimension. An unseen edge may be inconsequential for one claim and decisive for another. Missing a peripheral acquaintance may not change a target network substantially; missing the relation through which funding, authority, coercion, or coordination travels can

reorganize the interpretation of the whole configuration.

Definition 24.101 (Relational missingness sensitivity envelope). A *relational missingness sensitivity envelope* is the range of substantively plausible unobserved relations or higher-order configurations under which a specified relational conclusion remains stable, changes in degree, changes in type, or becomes unsupported.

The envelope is necessarily claim-relative. A conclusion about whether two observed actors communicated can remain robust even when much of the wider network is missing. A conclusion about centrality, gatekeeping, dependence, or field position can be far more sensitive to unseen ties. Reporting a single estimated structure without this distinction can create false confidence.

Missingness can also be patterned by the system itself. Powerful actors may communicate through less observable channels; informal care and household labor may remain outside administrative records; precarious actors may leave fewer durable traces; platform architectures can make some interactions visible while hiding others; archives can preserve institutional voices unevenly. In such cases missingness is not only an obstacle to reconstructing relational reality. The pattern of missingness can itself be a manifestation of inequality, strategic concealment, institutional legibility, or power.

Definition 24.102 (Structurally informative relational missingness). *Structurally informative relational missingness* is patterned non-observation for which there is independent reason to treat the probability, form, or location of missing relations as partly generated by the relational organization being studied.

The phrase “independent reason” is important. Researchers should not infer a hidden power relation merely because data are absent. Evidence about the observation process, incentives, institutional recording rules, concealment mechanisms, or comparison cases is needed before missingness becomes substantive evidence.

Proposition 24.103 (Missingness-sensitive relational claim). A *GRE claim about relational position, configuration, higher-order organization, or field structure should report sensitivity to plausible unseen relations whenever such relations could materially change the target property, while distinguishing uncertainty caused by missingness from evidence that the missingness mechanism is itself relationally generated*.

24.5.8 Limits of Relational Reduction

The preceding subsections identify specification limits within relational analysis. A more general danger arises when relational language becomes so inclusive that it absorbs every competing explanation. If material properties, internal organization, biological constraints, technical mechanisms, phenomenological qualities, legal validity, symbolic content, or domain-specific processes are always redescribed as “relations,” relational analysis loses the ability to say what would count as evidence for a genuinely different explanatory structure.

This issue is related to but distinct from the ontological limit discussed in Section 24.2. The ontological question asks whether reality may contain objects or properties not exhausted by relational constitution. The present question is methodological and explanatory: even if some object is relationally constituted in a broad

metaphysical sense, is a relational description sufficient to explain the target mechanism at the required resolution? A semiconductor can depend on relational organization while still requiring physical properties for a technical explanation. A legal relation can be socially generated while legal validity depends on domain-specific rules not recoverable from a generic network description. An experience can be socially conditioned while its phenomenological character remains analytically significant.

Definition 24.104 (Relational reduction). *Relational reduction* is an explanatory strategy that treats target-relevant properties, mechanisms, or constraints as adequately accounted for by relations or relational configurations while omitting non-relationally represented or domain-specific components that make an independent material difference to the claim.

Relational reduction is not identical to relational explanation. A strong relational explanation can show that a position, connection, dependency, rule, or distributed structure makes a substantial difference while leaving room for internal, material, technical, legal, ecological, psychological, or other components. The question is whether those omitted components alter the explanation rather than whether they can be redescribed relationally at some sufficiently abstract level.

Definition 24.105 (Mixed explanatory architecture). A *mixed explanatory architecture* combines relational mechanisms with independently specified entity-level, material, technical, institutional, phenomenological, normative, or other domain-specific components when the target claim depends materially on more than relational organization alone.

Mixed explanation is not a retreat from GRE. It can increase relational precision by preventing relations from carrying explanatory burdens they do not need to bear. GRE's distinctive contribution can concern how the components are connected, transformed, allocated, or made generative without claiming that every component is exhaustively relational at the operative analytical level.

Proposition 24.106 (Bounded relational explanation). *A relational explanation can be strong without being exhaustive: GRE should claim relational sufficiency only when plausible independently specified components fail to add target-relevant explanatory discrimination at the boundary, scale, temporal horizon, and resolution of the inquiry.*

This proposition provides a practical test against conceptual inflation. If every rival mechanism can be absorbed into an ever broader notion of relation, the framework becomes difficult to challenge. By contrast, bounded relational explanation asks what additional evidence or mechanism would change the result and permits another explanatory vocabulary to carry that part of the account when warranted.

Definition 24.107 (Relational-explanation revision trigger). A *relational-explanation revision trigger* is evidence that a GRE relational conclusion changes materially under a substantively warranted alternative boundary, scale, relation identification, continuity criterion, higher-order specification, field reconstruction, missingness scenario, or independently specified non-relational or domain-specific mechanism.

Revision need not imply abandonment. The response can be narrower scope, a different scale, a retyped relation, a discontinuity in the historical trajectory, a higher- or lower-order representation, a revised field boundary, an uncertainty interval over

missing structure, or a mixed explanatory architecture. More substantial revision is required when relational formulations repeatedly fail to discriminate among rival explanations or when non-relationally represented mechanisms systematically outperform them for the programme's central targets.

Relational limits therefore do not undermine the relational orientation of GRE. They specify the conditions under which that orientation remains informative. Boundaries can be permeable without becoming irrelevant; scales can transform relations without making comparison impossible; relation types can be uncertain without collapsing into arbitrary labels; persistence can be historical without being assumed; higher-order structures can be represented without maximizing formal complexity; fields can capture distributed conditioning without becoming residual metaphors; missingness can be analyzed without turning absence into speculation; and relational explanation can remain powerful without claiming exhaustiveness. The resulting discipline is one of *bounded relationality*: relations remain central analytical objects, but their identification, organization, and explanatory reach are continually tested against alternative specifications and mechanisms. The next section extends this critical discipline through time by examining historical reconstruction, missing archives, retrospective bias, changing categories, multiple timescales, fast-slow assumptions, criticality hypotheses, non-teleology, and the limits of historical generalization.

24.6 Historical Limits

The preceding sections examined limits arising from ontology, epistemic access, manifestation and representation, and relational specification. Historical inquiry concentrates these difficulties because its objects are temporally displaced, its traces are selectively produced and preserved, its categories change, and its explanatory mechanisms can operate across several timescales at once. The role of this section is therefore to specify the limits internal to historically informed GRE rather than to restate that economic structures have histories. Its objective is to distinguish what can be reconstructed from surviving evidence, what remains historically underdetermined, how later knowledge can distort earlier possibility structures, when temporal decompositions are warranted, and what evidential burden should accompany fast-slow, criticality, and cross-period generalizations. The discussion proceeds through historical reconstruction, missing archives, retrospective bias, changing categories, multiple timescales, fast-slow assumptions, criticality hypotheses, non-teleology, and the limits of historical generalization. The method is reconstructive and comparative: historical claims are treated as warrant-bearing interpretations whose evidential pathways, category bridges, temporal resolutions, and transport conditions should remain inspectable.

Chapter 23 established that economic claims depending materially on inherited institutions, sequence, changing categories, or temporal coupling should remain answerable to historical reconstruction. The present section adds a complementary restraint: historical reconstruction itself is limited. A historically situated GRE should therefore avoid two symmetrical errors. The first is presentism, in which current categories and outcomes are projected backward as though they organized the past in

Table 24.6: Historical limits and corresponding GRE disciplines

Historical limit	Risk to inference	Required GRE discipline
Reconstruction	One surviving chronology is treated as the uniquely warranted generative history	Preserve rival histories compatible with the evidence and distinguish chronology from mechanism
Missing archives	Surviving traces are mistaken for an unbiased sample of past relations	Reconstruct record production, preservation, access, and detection conditions
Retrospective bias	Known outcomes reorganize earlier possibilities into an apparently inevitable path	Reconstruct contemporaneous information, constraints, and feasible alternatives
Changing categories	Stable labels are treated as stable historical objects	Trace category genealogy, semantic drift, institutional use, and comparison bridges
Multiple timescales	One temporal resolution is imposed on processes operating at different rates	Specify process-relative clocks and test cross-scale conclusions for temporal aliasing
Fast-slow assumptions	Rate separation is presumed rather than historically demonstrated	Treat fast-slow structure as regime-dependent and test for coupling, inversion, and changing rates
Criticality hypotheses	Volatility, transition, or sensitivity is labeled “critical” without discriminating evidence	State the criticality claim type, expected signatures, rival mechanisms, and failure conditions
Teleology	Later stabilization or value is read backward as historical direction or purpose	Preserve branch structure, contingency, failed alternatives, and non-progressive generation
Historical generalization	A mechanism found in one period is transported to another without warrant	Specify invariants, changed conditions, domain of transport, and period-specific remainder

the same way. The second is historical insulation, in which invocation of contingency makes historical claims too elastic to be corrected. Historical humility is strongest when the reconstruction specifies both what the evidence supports and what would require reinterpretation.

Definition 24.108 (Historical limitation profile). A *historical limitation profile* records, for a specified GRE claim, the temporal interval and resolution, surviving evidence, archive and record-production conditions, category changes, contemporaneous possibility structure, relevant timescales, proposed historical mechanism, rival reconstructions, and conditions under which the claim should be narrowed, retyped, or revised.

Table 24.6 summarizes the principal historical limitations developed below and the corresponding discipline required of GRE.

24.6.1 Historical Reconstruction

Historical reconstruction in GRE is an inverse problem with a temporal asymmetry. The researcher observes surviving traces in the present and attempts to infer earlier relational configurations, sequences, constraints, and generative mechanisms. Chapter 7 developed relational reconstruction as a methodological task, while Section 24.3 showed why inverse problems need not yield a unique antecedent configuration. Historical reconstruction adds a further difficulty: the observation process itself changes through time. Institutions create records unevenly, categories are revised, actors alter practices, archives are reorganized, and later events affect which earlier traces become salient enough to preserve or retrieve.

A chronology can therefore be well established while the mechanism generating it remains uncertain. Knowing that a statute preceded an organizational change does not establish that the statute caused the change. Knowing that a price transition, po-

litical crisis, technological release, or institutional merger occurred at a particular date does not determine which relational mechanisms made the transition possible. Conversely, incomplete chronology need not preclude every historical claim if some higher-level property is stable across the serious orderings compatible with the evidence.

Definition 24.109 (Historical reconstruction envelope). A *historical reconstruction envelope* is the set of serious historical configurations, event orderings, relation structures, and generative mechanisms that remain compatible with the surviving evidence, explicit source assumptions, temporal resolution, and currently warranted category interpretation relevant to a specified claim.

The envelope is claim-relative. A reconstruction may be too indeterminate to establish who initiated a particular informal agreement while still supporting a strong conclusion that a new coordination relation existed before the formal institution that later recorded it. Similarly, disagreement about the exact onset of an institutional transition can coexist with agreement that the transition occurred within a bounded interval and altered later feasible paths.

Historical narrative itself can compress the reconstruction envelope. Narrative requires selection, sequence, and emphasis. These operations are indispensable, but they can create an appearance of continuity or causal direction stronger than the underlying evidence warrants. Historical analysis should therefore distinguish narrative coherence from evidential uniqueness. Abbott's emphasis on temporality and sequence and Sewell's analysis of transformative events both caution against treating social processes as temporally homogeneous or reducible to static covariates Abbott 2001; Sewell 1996.

Proposition 24.110 (Reconstruction-specific historical warrant). A *historically grounded GRE claim* should be no more specific about sequence, relation, mechanism, or agency than the corresponding historical reconstruction envelope permits, unless additional evidence discriminates among the remaining serious reconstructions.

This proposition does not require historical agnosticism. It requires matching inferential granularity to historical warrant. Strong conclusions can survive incomplete reconstruction when they concern properties shared across the serious histories. Weakly supported details should remain weakly supported even when they make a narrative more elegant.

24.6.2 Missing Archives

Historical evidence is not produced by a neutral recording device. Records arise within organizations, states, households, firms, courts, movements, platforms, communities, and administrative systems that differ in what they record, whose actions count as recordable, how long records survive, and who can later access them. Archival scholarship has repeatedly emphasized that archives participate in the production of historical memory rather than functioning merely as passive containers Schwartz and Cook 2002; Stoler 2009. Trouillot likewise shows how silences can enter at several stages of historical production, from fact creation to archival assembly and retrospective significance Trouillot 1995.

For GRE, archival incompleteness is especially consequential because missing records can distort relational structure. Formal contracts may survive while informal care, trust, coercion, negotiation, and household labor leave sparse traces. Large institutions can preserve correspondence, minutes, accounts, and legal files while precarious organizations or marginalized actors leave fragmented records. A later researcher can therefore observe a dense documentary network around actors who were record-rich and a sparse network around actors who were historically important but weakly archived.

Definition 24.111 (Historical observability profile). A *historical observability profile* records which historically relevant actors, relations, events, categories, and material processes were likely to generate traces; the institutions controlling record production and retention; known destruction, dispersal, secrecy, or access restrictions; cataloging and retrieval conditions; and the expected consequences of these processes for the reconstruction at issue.

A missing document is not yet evidence that the underlying event or relation was absent. The evidential value of non-observation depends on detection conditions. If a transaction would almost certainly have generated a surviving standardized record, its absence can matter. If the relevant relation was informal, secret, poorly archived, or outside the institution's recording ontology, non-observation carries much less weight.

Definition 24.112 (Archival absence warrant). An *archival absence warrant* is the independently supported basis for inferring that non-observation of a historical trace provides evidence against the occurrence of a specified event, relation, or institutional act because the relevant record-production, preservation, access, and retrieval conditions would ordinarily have made the trace observable.

This distinction prevents two opposing mistakes. One is evidential positivism: only what survives in the archive is treated as historically real. The other is speculative compensation: any missing relation can be asserted because the archive is incomplete. The historical observability profile and archival absence warrant constrain both moves.

Missingness can also be substantively generated. Secrecy, exclusion, informal organization, unequal literacy, discriminatory administrative categories, strategic destruction, and power over record systems can affect what survives. Yet, as Section 24.5 argued for relational missingness generally, absence becomes evidence of such a mechanism only when the observation process is independently reconstructed. Historical silence can motivate inquiry; it cannot by itself prove the relation proposed to explain the silence.

Proposition 24.113 (Archive-conditioned historical claim). *When the evidential support for a GRE historical claim depends materially on records whose production, preservation, access, or retrieval is systematically unequal, the claim should incorporate that archival selection process into its uncertainty or mechanism analysis rather than treating surviving traces as an unconditioned sample of the past.*

24.6.3 Retrospective Bias

Historical actors did not know the future that the researcher knows. Once an outcome is known, earlier events can be reorganized into a sequence that appears to point toward it. Signals that mattered only in retrospect become highlighted; failed alternatives disappear; actors who later became central seem important from the beginning; and contingent turning points are redescribed as stages in an emerging order. Retrospective knowledge can therefore alter not only interpretation of the past but the reconstructed topology of earlier possibility.

This problem is not solved by refusing hindsight altogether. Later evidence can reveal structures that contemporaries could not observe, and retrospective comparison can identify consequences that only became visible over longer horizons. The task is to distinguish legitimate retrospective knowledge from illegitimate projection of later categories, outcomes, and significance backward into the earlier decision environment.

Definition 24.114 (Contemporaneous possibility profile). A *contemporaneous possibility profile* reconstructs, for a specified historical position, the information plausibly available at the time, recognized categories, institutional and material constraints, feasible alternatives, anticipated consequences, relevant uncertainties, and relations through which actors could perceive or act on those possibilities.

The profile is not a claim that actors perceived every objectively available alternative. It separates at least three sets: alternatives later imaginable to the historian, alternatives structurally accessible in the historical configuration, and alternatives recognized or actionable from the position of particular actors. Conflating these sets can make past decisions appear irrational, inevitable, or morally obvious in ways that depend on later knowledge.

Path dependence provides an important example. Pierson's work on increasing returns illustrates how sequences can make later reversal progressively costly Pierson 2000. But path dependence should not be inferred merely because a path persisted. Persistence observed after the fact does not establish that early alternatives were equivalent, that increasing returns operated, or that a small initial contingency determined the outcome. A mechanism must connect sequence to changing later accessibility.

Definition 24.115 (Outcome-knowledge contamination). *Outcome-knowledge contamination* occurs when knowledge of a later historical outcome changes the inferred significance, probability, feasibility, agency, or category of earlier events beyond what is warranted by contemporaneous structure and surviving evidence.

Proposition 24.116 (Retrospective-separation requirement). A *GRE historical explanation* should distinguish what is warranted retrospectively about the realized trajectory from what was knowable, feasible, or salient within the earlier historical configuration whenever the distinction materially affects claims about agency, contingency, responsibility, or path dependence.

This requirement also protects normative analysis. Historical actors can remain responsible for evidence, harms, or alternatives available to them without being judged as though they possessed later knowledge. Conversely, the fact that actors lacked later knowledge does not immunize choices when contemporaneous evidence already sup-

ported criticism.

24.6.4 Changing Categories

Historical comparison requires categories, but categories themselves have histories. Terms such as “worker,” “household,” “firm,” “property,” “unemployment,” “credit,” “citizen,” “skill,” “care,” “platform,” or “artificial intelligence” can change in legal definition, statistical construction, institutional use, social meaning, and practical consequence. A stable word can therefore refer to different relational objects across periods, while different words can organize partially continuous practices.

Classification systems are also active institutions. Bowker and Star show how classifications organize social and technical worlds rather than simply reflecting them Bowker and Star 1999. Section 24.4 developed this point for representation generally. Historical analysis adds semantic drift and institutional succession: a category can change while records preserve the same column heading, or the category can remain formally stable while the practices it governs change substantially.

Definition 24.117 (Historical category genealogy). *A historical category genealogy reconstructs the emergence, definitions, institutional carriers, inclusion and exclusion rules, practical uses, contested meanings, and transformations of a category across the historical interval relevant to a GRE comparison.*

A genealogy makes comparison harder but more defensible. It can reveal that two periods are directly comparable for one purpose but not another. A historical wage series, for example, may remain useful for a price-adjusted income question even if employment categories changed, while a claim about occupational status or labor-market participation may require a more substantial bridge.

Definition 24.118 (Historical category bridge). *A historical category bridge specifies the dimensions on which two temporally separated categories or category instances are treated as comparable, the transformations required to construct that comparison, the dimensions intentionally left non-equivalent, and the evidence supporting the bridge.*

The bridge should preserve translation loss. It should not silently harmonize away the historically meaningful difference that the inquiry is trying to understand. Koselleck’s work on historical semantics is especially relevant to the problem that concepts carry temporal structures and changing horizons of expectation Koselleck 2004.

Proposition 24.119 (Category-continuity restraint). *Continuity of a historical label should not be treated as continuity of the represented economic or relational object, and discontinuity of labels should not be treated as discontinuity of the object, without an explicit category genealogy and claim-specific comparison bridge.*

This restraint matters for long-run datasets as much as for qualitative narrative. Harmonization can be analytically useful, but every harmonized series is a representation produced by rules. Where the rules erase a historically consequential change in category, apparent temporal continuity can be manufactured by the researcher.

24.6.5 Multiple Timescales

Economic history rarely unfolds on one clock. Transactions, prices, attention, political decisions, organizational routines, professional formation, infrastructure, demography, legal doctrine, ecological regeneration, and cultural expectations can change at materially different rates. Chapter 23 developed multiscale historical interfaces; the present concern is the limit generated when a researcher imposes one temporal resolution on processes whose explanatory relations depend on several.

A yearly dataset may be appropriate for one institutional process and too coarse for a financial panic occurring within days. A daily dataset may capture market movements while being too short to identify changes in professional formation or land-use structure. Temporal aggregation can also reverse apparent sequence. Processes that look simultaneous at a decadal scale may have a meaningful order at the monthly or yearly scale, while high-frequency fluctuations can obscure a slower institutional transformation.

Definition 24.120 (Historical timescale profile). *A historical timescale profile identifies the processes relevant to a historical GRE claim, their substantively warranted temporal resolutions or characteristic durations, the evidence available at those resolutions, and the cross-scale relations through which change at one timescale conditions or is conditioned by change at another.*

The profile avoids treating a timescale as an intrinsic property of an entity. A central bank can act within hours during a crisis and evolve institutionally over decades. A household can make an immediate purchase while reproducing wealth relations across generations. What counts as fast or slow is therefore process-relative and regime-dependent.

Definition 24.121 (Temporal aliasing in historical inference). *Temporal aliasing in historical inference occurs when the temporal resolution of evidence or analysis makes distinct processes, sequences, oscillations, delays, or transitions appear equivalent, simultaneous, reversed, or absent in a way that materially changes the historical conclusion.*

Temporal aliasing can affect causal interpretation. If an institutional response is observed only annually, a sequence of rapid intervention, temporary reversal, and later stabilization may appear as a smooth annual change. Conversely, selecting a very fine resolution can exaggerate short-lived fluctuations while concealing the slower constraint that bounds them.

Proposition 24.122 (Multiscale historical adequacy). *A historical GRE claim involving mechanisms that plausibly operate at materially different temporal resolutions should identify the relevant timescales and test whether the conclusion is stable under alternative defensible temporal aggregations or requires an explicitly coupled multiscale account.*

24.6.6 Fast–Slow Assumptions

Fast–slow language is useful when some processes change sufficiently rapidly relative to others that partial separation clarifies the mechanism. It becomes misleading when “fast” and “slow” are treated as permanent types of variable or institution.

Rates can change historically. A legal process that is usually slow can become rapid during emergency legislation. A technological standard can remain stable for years and then change quickly. A market that usually adjusts rapidly can freeze. Educational or demographic processes can interact with sudden policy shocks in ways that invalidate ordinary rate separation.

The historical question is therefore not whether one variable can be named fast and another slow, but whether a relevant interval exhibits sufficient rate separation for the intended inference. The answer depends on process definition, temporal resolution, coupling strength, and regime.

Definition 24.123 (Historical rate-separation profile). A *historical rate-separation profile* records the processes compared, the interval and regime in which their rates are estimated or interpreted, evidence for the relative rate difference, coupling between the processes, known transitions in characteristic rates, and the inference that depends on treating the processes as comparatively fast or slow.

A strong separation in one regime can disappear in another. This motivates attention to *fast-slow inversion*: a process ordinarily treated as background can become the rapidly changing driver, while a process ordinarily treated as responsive can become constrained or frozen. Historical episodes involving war, crisis, technological discontinuity, constitutional change, ecological shock, or rapid institutional mobilization can produce such inversions.

Definition 24.124 (Fast-slow regime failure). A *fast-slow regime failure* occurs when the rate separation, weak coupling, or quasi-stationarity required for a fast-slow interpretation no longer holds over the historical interval relevant to the claim.

Fast-slow analysis can also import false causal direction. The slower process is not automatically the structural cause and the faster process is not automatically the response. Slow variables can constrain without determining; fast variables can accumulate into structural change; and cross-scale feedback can run in both directions.

Proposition 24.125 (Regime-bounded fast-slow claim). A *GRE fast-slow interpretation* should be stated as a *regime-bounded historical claim* whose validity depends on demonstrated relative rates, coupling, and temporal resolution, and it should be revised when rate separation collapses, reverses, or ceases to support the inferred mechanism.

24.6.7 Criticality Hypotheses

Criticality is potentially valuable to GRE because systems near qualitative transition can display heightened sensitivity, changing correlation structure, large responses to comparatively small perturbations, and reorganization of accessible trajectories. Earlier chapters used criticality cautiously as one possible analytical hypothesis. The historical limit arises when transition, instability, volatility, or retrospective importance is redescribed as criticality without specifying what kind of criticality is proposed and what evidence distinguishes it from alternative mechanisms.

Historical data are particularly vulnerable to post hoc criticality claims. Once a major transition is known, preceding fluctuations can be interpreted as warning signals even when similar fluctuations occurred in periods without transition. Sparse temporal data can make an apparent divergence or slowdown an artifact of measure-

ment resolution. Institutional coordination, external shock, strategic action, threshold rules, contagion, or ordinary nonlinear response can sometimes produce patterns resembling selected signatures associated with critical transitions.

Definition 24.126 (Historical criticality claim profile). A *historical criticality claim profile* identifies the proposed critical phenomenon, system boundary, order or state variables, historical interval, expected signatures, evidence resolution, candidate perturbations, rival transition mechanisms, and observations that would weaken or defeat the criticality interpretation.

The profile should also classify the status of the claim. A criticality metaphor organizes attention to sensitivity near transition. A structural criticality hypothesis proposes specific relational or dynamical features without complete empirical parameterization. An empirically parameterized criticality model carries stronger commitments about observables, scaling, or transition structure. These levels should not be rhetorically merged.

Definition 24.127 (Criticality attribution remainder). A *criticality attribution remainder* is the part of an observed historical transition pattern that remains equally or better compatible with serious non-critical mechanisms after the expected criticality signatures and data limitations have been specified.

A large attribution remainder does not make criticality useless. It changes the epistemic status from explanation toward heuristic or open hypothesis. Historical cases can still motivate formal or comparative research without being treated as completed confirmations.

Proposition 24.128 (Criticality evidential restraint). A *historical GRE account should not infer criticality from transition importance, volatility, sensitivity, or qualitative change alone; the criticality interpretation should add discriminating expectations beyond those phenomena and remain answerable to rival mechanisms and non-transition comparison periods.*

This proposition is especially important for governance. If every crisis is called a critical point after it occurs, criticality cannot guide prospective observation or discriminate among policy environments. A useful criticality hypothesis must expose itself to the possibility that the system was unstable, nonlinear, strategically coordinated, externally shocked, or institutionally transformed without being critical in the relevant formal or structural sense.

24.6.8 Non-Teleology

GRE is generative, but generativity does not imply historical progress. A configuration can generate later capacities, institutions, values, dependencies, exclusions, harms, or possibilities without moving toward a predetermined end. Likewise, survival does not prove superiority, stability does not prove desirability, and increasing complexity does not establish advancement. Historical explanation becomes teleological when later existence, function, or value is treated as the purpose toward which earlier processes were directed without independent evidence for such purposive organization.

Teleology can enter subtly through vocabulary. An institution can be described

as “developing toward” its present form; a market as “maturing”; a technology as “inevitably replacing” another; an organization as “learning” a function that later became central. Such language may be warranted when actors explicitly pursued the end and their purposive action explains the path. It is not warranted merely because the end eventually occurred.

Definition 24.129 (Historical teleology diagnostic). A *historical teleology diagnostic* asks whether a claimed historical direction depends on independently evidenced actor purposes, selection mechanisms, institutional rules, or dynamical constraints operative during the process, or instead derives primarily from knowledge of the later outcome.

Non-teleology also requires preserving failed alternatives. Histories written only from surviving institutions can erase experiments, coalitions, technologies, norms, organizations, and policies that were once serious possibilities. Their failure can be theoretically informative because it reveals constraints, power relations, coordination problems, value conflicts, or contingent events that shaped the realized path.

Definition 24.130 (Historical branch-preservation requirement). The *historical branch-preservation requirement* is the discipline of retaining substantively supported unrealized alternatives in the reconstruction whenever their availability, closure, suppression, or failure materially affects claims about contingency, agency, power, generativity, or inevitability.

Proposition 24.131 (Non-teleological generativity). A *GRE claim that one historical configuration generated another should not by itself be interpreted as a claim that the later configuration was intended, historically necessary, normatively superior, or the natural completion of the earlier one.*

This proposition protects the concept of generation from becoming a philosophy of progress. Generative analysis asks how later possibilities became accessible or inaccessible. It can therefore examine decline, lock-in, destruction, failed coordination, institutional erosion, or harmful path formation with the same conceptual vocabulary used for capability creation.

24.6.9 Limits of Historical Generalization

Historical explanation seeks more than isolated description, yet historical mechanisms are often conditional on institutions, technologies, categories, material environments, legal orders, cultural meanings, and distributions of power that change across periods. The challenge is therefore to generalize without stripping away precisely the historical conditions that made the mechanism work.

A repeated pattern can support several different conclusions. It may reveal a genuinely portable mechanism; a family resemblance produced by different mechanisms; recurrence created by similar institutional conditions; or a classification imposed by the analyst. Conversely, a mechanism can be genuinely recurrent even when its surface manifestation differs because the categories, technologies, and institutions through which it operates have changed.

Definition 24.132 (Historical transportability profile). A *historical transportability profile* specifies the mechanism or relational structure proposed for transfer across

periods, the source and target historical regimes, conditions treated as invariant, conditions known to differ, required category bridges, relevant timescales, expected manifestation changes, and evidence capable of showing that the mechanism has ceased to transport.

Historical transportability is therefore stronger than analogy and weaker than timeless law. It is a conditional claim that a mechanism remains informative across a specified change in historical context. The profile should make the conditionality visible.

Definition 24.133 (Historical generalization remainder). *A historical generalization remainder is the period-specific structure, meaning, mechanism, or constraint that remains unexplained or distorted when a historical GRE concept or mechanism is transported from one temporal regime to another.*

A remainder can indicate that the generalization should be narrowed, decomposed, or abandoned. It can also identify the historically variable interface through which a more stable mechanism is realized. For example, a dependency mechanism may recur while the legal instruments producing it change; a value-conversion process may recur while the recognized value forms differ; a coordination problem may recur while communication technologies radically alter temporal scale.

Cross-period comparison should also resist selecting cases only because they culminate in the outcome of interest. Historical generalization becomes stronger when non-transition periods, failed cases, differently institutionalized cases, and periods with similar initial conditions but divergent trajectories are included. Such comparisons help separate a mechanism from the retrospective salience of successful or catastrophic outcomes.

Proposition 24.134 (Historically bounded generalization). *A GRE historical generalization should state the historical regimes across which it is claimed to transport, the invariants required for that transport, the category and timescale bridges used in comparison, the period-specific remainder, and the kinds of counterevidence that would restrict or defeat the generalization.*

The historical limits developed in this section do not make history inaccessible to GRE. They make historical claims more explicitly reconstructive. A defensible historical account can be strong while leaving some event orderings unresolved; use archives while modeling their selection; learn retrospectively without importing future knowledge into earlier agency; compare changing categories without pretending semantic identity; coordinate multiple timescales without assuming one universal clock; use fast-slow language without fixing rates permanently; investigate criticality without labeling every transition critical; analyze generation without presuming progress; and generalize across periods without erasing historical specificity.

Definition 24.135 (Historical revision trigger). *A historical revision trigger is new evidence or comparative analysis showing that a GRE historical conclusion depends materially on an unsupported reconstruction, archival selection effect, retrospective projection, invalid category bridge, inappropriate temporal resolution, failed rate-separation assumption, weakly discriminating criticality attribution, teleological inference, or non-transportable historical mechanism.*

Historical revision can therefore take several forms: widening the reconstruction

envelope, revising the archive model, restoring an unrealized branch, retyping a historical category, changing temporal resolution, replacing a fast-slow interpretation with a coupled account, downgrading criticality from explanation to heuristic, removing progressive language, or narrowing the period over which a mechanism is claimed to generalize. These are not merely defensive qualifications. They are ways in which historical evidence can actively restructure GRE.

The next section turns from historical reconstruction to formalization itself. It examines the limits of schematic, structural, analogical, and parameterized models; model closure and self-reference; the temptation of formal elegance; empirical warrant; and the conditions under which mathematical structure can or cannot be transferred into an economic-relational explanation.

24.7 Formalization Limits

The preceding sections examined limitations arising from historical reconstruction, relational specification, representation, epistemic access, and ontological commitment. Formalization introduces a different class of limits. A formal system can sharpen distinctions, expose assumptions, organize possible mechanisms, and make consequences traceable. The same precision can also exceed the precision of the underlying concepts, evidence, or historical reconstruction. The role of this section is therefore to specify when formalization strengthens GRE and when it creates a misleading appearance of determinacy. Its objective is to distinguish schematic, structural, analogical, and empirically parameterized uses of formal language; identify burdens associated with parameters, closure, self-reference, and empirical correspondence; and state limits on mathematical transfer, observation-transformation typing, 2-complex representation, and history-weight or amplitude-like models. The method is type-sensitive and claim-relative: a formal object is evaluated by what analytical work it performs, what semantics and evidence support that work, which assumptions are closed for tractability, and which conclusions remain warranted when the formal representation is changed.

GRE does not require a universal mathematical language. Different questions can call for partial orders, networks, dynamical systems, stochastic models, higher-order structures, fields, operator-like representations, category-theoretic diagrams, 2-complexes, qualitative schemata, or no formalism beyond carefully typed prose. Chapter 8 treated this plurality as methodological rather than hierarchical, while Chapter 15 developed several richer representations for historical-relational structure. The present section adds a stronger limitation principle: formal richness is not cumulative evidence. Adding mathematical structure can increase inferential power only when the added structure corresponds to a justified distinction in the target problem.

Definition 24.136 (Formalization limitation profile). A *formalization limitation profile* records, for a specified GRE formalism, its analytical role, model type, object and operation semantics, closure assumptions, parameter status, empirical or interpretive bridges, excluded relations, sensitivity to alternative representations, known non-identifiabilities, and conditions under which the formal result should be nar-

Table 24.7: Formalization limits and corresponding GRE disciplines

Formal limit	Primary risk	Required GRE discipline
Schematic form	Diagrammatic or symbolic organization is mistaken for a tested mechanism	State what the schema clarifies and what it does not establish
Structural form	Internal consistency is mistaken for empirical adequacy	Separate preserved structure from warranted correspondence to the target
Analogy	Imported mathematical properties acquire imported ontology or mechanism	Specify which relations transfer and which semantics remain domain-specific
Parameters	Numerical values appear estimable although the target quantities are weakly identified	Record measurement bridges, identification conditions, uncertainty, and equifinality
Closure	Excluded relations are treated as negligible by construction	State the closure purpose, remainder, and sensitivity to reopened interactions
Self-reference	Model outputs alter the modeled process while the model assumes passive observation	Represent feedback between representation, uptake, and later configuration where material
Formal elegance	Simplicity, symmetry, or tractability is treated as evidence	Evaluate elegance as a design virtue distinct from empirical warrant
Empirical warrant	Symbols have clearer semantics than their observational bridges	Match claim strength to independently supported correspondence
Math transfer	Similar equations or structures are treated as shared mechanisms	Preserve semantic, causal, historical, and ontological remainders
Type confusion	Observation/readout is modeled as if it were itself a state-changing operation	Keep observation and transformation maps distinct even when performatively coupled
2-complex	A 2-complex becomes a universal template	Test whether vertices, edges, faces, labels, and order relations preserve the target-relevant structure
History weights	Numerical support over histories is given probabilistic or physical meaning without warrant	State the weight semantics, normalization, composition, evidence, and interpretive limits explicitly

rowed, retyped, or abandoned.

Table 24.7 summarizes the principal limits developed below.

24.7.1 Schematic Models

A schematic model organizes distinctions and dependencies without claiming that every represented object has been measured or that every represented relation constitutes an empirically established mechanism. Flow diagrams, typed boxes, layered architectures, category maps, causal sketches, state-transition schemata, and compact symbolic summaries can all perform this role. They are especially useful in a developing research programme because they make assumptions visible and permit several empirical implementations to be compared against the same conceptual structure.

The limitation is that graphical or symbolic explicitness can be mistaken for evidential completeness. A diagram that distinguishes value generation, conversion, circulation, capture, return, and regeneration may clarify the vocabulary while leaving the existence, strength, or causal relevance of particular pathways untested. Likewise, a schematic representation of a field, history space, or conversion interface can expose candidate mechanisms without identifying which mechanism operates in a concrete case.

Definition 24.137 (Schematic adequacy profile). A *schematic adequacy profile* records the distinctions a schematic model is intended to preserve, the relations it

proposes for investigation, the empirical commitments it does and does not make, alternative schemata that remain compatible with the current evidence, and the observations or arguments that would require restructuring the schema.

A useful schematic model therefore has a bounded epistemic role. It should compress a conceptual problem while keeping the transition to stronger claims visible. This is important in GRE because a schema can later be instantiated by qualitative process evidence, network data, historical reconstruction, legal analysis, dynamical simulation, or another method. The schema should not prejudge which empirical route will prove adequate.

Proposition 24.138 (Schematic non-upgrade condition). *The internal coherence or repeated reuse of a GRE schema does not by itself upgrade a proposed relation, mechanism, or process from a conceptual possibility to an empirically warranted claim.*

The proposition matters for cumulative theory building. A concept can become familiar through repeated diagrams and notation long before its empirical status improves. GRE should therefore distinguish stabilization of vocabulary from accumulation of evidence.

24.7.2 Structural Models

Structural models represent typed objects and relations more strongly than schemata. They may specify adjacency, order, composition, dependency, incidence, nesting, admissible transformation, or another formal relation whose internal consequences can be derived. A network model can represent ties and paths; a partially ordered event model can represent precedence constraints; a category-theoretic diagram can represent typed mappings and compositional requirements; a 2-complex can represent linked vertices, edges, and faces across a historical-relational structure.

The principal limit is correspondence. A structural theorem establishes what follows within the model under stated assumptions. It does not automatically establish that the empirical target has the modeled structure, that the structural relation has the proposed substantive meaning, or that omitted dimensions are irrelevant. Two empirical systems can share one structural representation while differing radically in mechanism, history, normativity, or material constitution.

Definition 24.139 (Structural correspondence profile). *A structural correspondence profile records the formal objects and relations of a model, the target objects and relations they represent, the evidence or argument supporting each correspondence, structural features intentionally omitted, transformations under which the correspondence is expected to remain valid, and conclusions that depend on stronger correspondence than has been established.*

Structural adequacy is therefore claim-relative. A graph representation may be adequate for identifying brokerage while inadequate for distinguishing authority from friendship. A partial order may preserve temporal precedence while discarding duration, intensity, or simultaneous interaction. A categorical diagram may clarify compositional typing while saying little about empirical magnitude. The appropriate question is not whether the model is structurally elegant in the abstract, but whether it preserves the distinctions needed for the particular inference.

Proposition 24.140 (Structural non-equivalence condition). *Formal structural equivalence between two representations does not establish equivalence of mechanism, historical formation, normative status, or ontology unless those further correspondences are independently warranted.*

This condition also limits cross-domain inference. Isomorphic or homomorphic structure can support comparison, but the preserved structure must be identified explicitly before any substantive conclusion is transferred.

24.7.3 Analogical Models

Analogical models import selected mathematical structure from another domain because that structure helps formulate a question in GRE. Terms such as field, attractor, phase transition, criticality, amplitude, topology, symmetry, operator, or spacetime can be analytically productive when the imported structure is specified and the local semantics are reconstructed. The history of science contains many fruitful analogies, but usefulness of an analogy does not erase the difference between source and receiving domains.

The limitation arises when analogy becomes semantic inheritance. A social field need not share the ontology, conservation laws, metric structure, locality conditions, or measurement procedures of a physical field. An attractor-like pattern need not be generated by the same equations as a physical dynamical system. A topology-inspired representation of relational continuity does not establish that the target possesses a mathematically complete topology. An amplitude-like history construction does not inherit quantum-mechanical interpretation merely because complex numbers or compositional sums are used.

Definition 24.141 (Formal analogy dossier). *A formal analogy dossier records the source formalism, the receiving GRE problem, the specific structure being imported, the properties intentionally preserved, source-domain properties not transferred, reconstructed local semantics, added analytical value, and empirical or conceptual tests that could show the analogy to be misleading.*

The dossier makes analogy productive precisely by refusing total identification. An analogy can be valuable when it reveals a previously unnoticed distinction, suggests a counterexample, permits a new decomposition, or generates a testable mechanism. It becomes weak when its main support is terminological resemblance or mathematical sophistication.

Proposition 24.142 (Analogy restraint condition). *A GRE inference based on imported mathematics should depend only on those source-formal properties whose receiving-domain interpretation has been separately defined and defended; untransferred source-domain properties carry no automatic inferential authority.*

This principle keeps mathematical borrowing open while preventing metaphysical or empirical conclusions from entering through notation without argument.

24.7.4 Parameter Identification

A model becomes more empirically demanding when its parameters are intended to correspond to measurable or inferable quantities. Parameters can represent rates,

strengths, thresholds, transition propensities, elasticities, decay, coupling, accessibility, history weights, or other target-relevant quantities. Numerical specification can improve comparison and falsifiability, but only if the parameters are identifiable under the available evidence and model structure.

Parameter identification differs from numerical fitting. A fitting procedure can return a value even when several parameter combinations generate observationally indistinguishable behavior. A parameter can also be statistically identifiable while its substantive interpretation remains weak because the measured proxy does not isolate the intended relation. Historical and reflexive systems add further difficulty because the parameter itself can change when institutions, categories, or actor responses change.

Definition 24.143 (Parameter-identification profile). A *parameter-identification profile* records the parameter's substantive meaning, observational or interpretive bridge, estimation or calibration procedure, data requirements, structural assumptions, alternative parameter combinations compatible with the evidence, temporal and domain stability assumptions, uncertainty, and the conclusions sensitive to the parameter's value.

The profile should distinguish several situations. In direct identification, the parameter has a clear empirical referent and sufficient observations. In indirect identification, the parameter is inferred through a model whose other assumptions materially contribute to the estimate. In calibration, the value is chosen to reproduce selected patterns without being uniquely inferred from them. In exploratory specification, the parameter ranges over plausible values to test qualitative behavior. These statuses should not be collapsed into one category of "estimated parameter."

Definition 24.144 (Formal equifinality). *Formal equifinality* occurs when materially different parameter settings, model structures, or mechanism specifications generate outputs that are insufficiently discriminated by the available evidence relevant to the target claim.

Equifinality is not necessarily fatal. A conclusion can remain robust if it is shared across the serious parameter and model combinations. The limitation concerns claims that depend on selecting one combination without discriminating evidence.

Proposition 24.145 (Identification-proportional parameter claim). *The substantive interpretation assigned to a GRE parameter should be no stronger than the identification of the parameter's empirical referent, model dependence, and serious equifinal alternatives permit.*

This proposition prevents quantitative precision from concealing semantic uncertainty.

24.7.5 Model Closure

Formal analysis requires boundaries. A model chooses which entities, relations, variables, events, mechanisms, and external influences to represent. Some interactions are held fixed, aggregated, treated as exogenous, or excluded entirely. Such closure is not inherently a defect. Without closure, many analytical questions would be impossible to formulate. The limitation arises when a tractability choice is silently converted

into a claim about causal irrelevance.

Economic systems are especially difficult to close because the relevant boundaries can cross law, politics, ecology, technology, education, social reproduction, and epistemic infrastructure. Chapter 23 developed these interfaces as reciprocal dependencies rather than residual context. A formal GRE model should therefore preserve an explicit remainder when closure excludes relations capable of altering the model's mechanism or result.

Definition 24.146 (Closure specification). A *closure specification* records the analytical boundary of a formal model, endogenous and exogenous objects, fixed or suppressed relations, assumed environmental regularities, reasons for the closure, and the conditions under which excluded interactions are expected to become materially relevant.

Definition 24.147 (Closure remainder). A *closure remainder* is the set of excluded, aggregated, externally fixed, or weakly represented relations whose plausible variation could alter the interpretation, mechanism, or conclusions of the formal model.

The remainder can be studied through sensitivity analysis, nested models, alternative boundaries, qualitative comparison, or explicit coupling to another domain model. The appropriate method depends on the question. A model of a local conversion interface, for example, need not include the entire political economy if the excluded structures are stable relative to the claim. The same model becomes inadequate if legal reclassification, infrastructure ownership, or ecological constraint changes the feasible conversion process.

Proposition 24.148 (Reopenable closure condition). A GRE formalization can legitimately close selected relations for analysis when the closure is explicit and the principal conclusion remains inspectable under plausible reopening of interactions that could materially change the modeled mechanism.

Closure is therefore a research design decision rather than a declaration that the world is closed.

24.7.6 Self-Reference

Some GRE models concern systems in which classifications, forecasts, indicators, recommendations, and models themselves enter the relational field. Sections 24.3 and 24.4 examined observer participation and performative representation. Formalization creates an additional problem: a model may assume a fixed target while publication or institutional use of the model changes the behavior, expectations, rules, or resource allocations that constitute that target.

Self-reference can occur at several levels. Actors may respond strategically to a metric. Institutions may redesign procedures around a model-generated risk score. Researchers may change sampling or classification after seeing preliminary outputs. Policymakers can alter rules on the basis of a forecast, thereby changing the process whose future was forecast. An AI system can generate recommendations that influence the data used for later retraining. In each case, the formal model participates in the later object of inquiry.

Definition 24.149 (Formal self-reference profile). A *formal self-reference profile*

records how a model, indicator, forecast, classification, or formal output can become known to participants, what uptake pathways are available, which modeled variables or relations can respond to that uptake, relevant delays, and whether subsequent observations remain interpretable under the original model specification.

Not every model requires endogenous self-reference. A historical model of a closed period may have no causal pathway from present analysis to past events. A laboratory model may successfully isolate feedback. The burden rises when model outputs are institutionalized or public and the target is reflexive.

Proposition 24.150 (Reflexive model-revision condition). *When uptake of a GRE model or its outputs can materially change the relations or decision rules represented by that model, later empirical evaluation should distinguish prediction error from target transformation induced partly by the model's own circulation.*

The proposition preserves both accountability and learning. A forecast need not be judged wrong merely because a response to the forecast prevented the predicted event, but neither should performativity be invoked automatically to protect an inaccurate model.

24.7.7 Formal Elegance

Formal elegance is a genuine intellectual virtue. Parsimony, symmetry, compositional clarity, invariance, tractability, and compact representation can reveal deep relations and make a model easier to inspect. GRE should not reject elegance simply because economic and social systems are complex. The limitation is evidential: elegance is a property of a representation, not direct evidence that the world possesses the represented regularity.

A particularly elegant model can become attractive because it compresses many cases into one architecture. This creates a risk of protecting the architecture by reinterpreting every anomaly as a special case, omitted variable, boundary effect, or hidden relation. At that point, elegance can reduce rather than increase falsifiability. The relevant discipline is therefore to preserve model competition and specify which empirical differences would favor a less elegant but better-supported alternative.

Definition 24.151 (Formal-elegance separation). *Formal-elegance separation* is the explicit distinction between virtues of a representation, such as simplicity, symmetry, tractability, compositionality, or unification, and evidential warrant for the substantive claims represented by that formal structure.

Elegance can legitimately influence model selection when empirical adequacy is otherwise comparable, or when a simpler model achieves the same explanatory discrimination with fewer assumptions. It should not compensate for missing correspondence, unidentified parameters, or failed predictions.

Proposition 24.152 (Elegance non-compensation condition). *Formal elegance cannot compensate for absent semantic definition, unsupported empirical correspondence, unidentified parameters, or systematic counterevidence relevant to the claim the model is intended to support.*

This condition is especially important for ambitious cross-domain formalisms, where aesthetic appeal can otherwise be mistaken for theoretical maturity.

24.7.8 Empirical Warrant

Formalization becomes empirically consequential only through bridge claims connecting formal objects to observations, records, interpretations, or interventions. A symbol can be precisely defined within the model while its relation to an empirical object remains uncertain. Section 24.4 called attention to a symbolic-determinacy gap; the present subsection asks how that gap limits formal conclusions.

Empirical warrant has several layers. The target object must be identified. The manifestation or measurement process must support the represented variable or relation. The formal operation must correspond to a substantively meaningful transformation or comparison. The conclusion must remain stable enough under plausible measurement and model uncertainty. Where these layers differ in strength, the final claim should be limited by the weakest bridge material to the inference.

Definition 24.153 (Formal empirical-bridge profile). *A formal empirical-bridge profile records the target object, formal representation, observations or interpretations supporting the correspondence, measurement and manifestation assumptions, uncertainty, rival representations, and the inferential steps by which a formal result is translated back into an empirical GRE claim.*

A formal result can also have conceptual value without an empirical bridge. An impossibility result under stated assumptions can show that a proposed conceptual package is internally inconsistent. A toy model can reveal a possible mechanism. A structural counterexample can demonstrate that one inference does not follow logically from another. Such contributions should be described as conceptual or structural rather than empirically validated.

Proposition 24.154 (Empirical-bridge bottleneck). *The empirical strength of a GRE conclusion derived from a formal model cannot exceed the warranted correspondence connecting the model's objects, operations, and assumptions to the target phenomenon relevant to that conclusion.*

This proposition allows sophisticated mathematics and epistemic humility to coexist. A mathematically strong result can remain a conditional result until the bridge is strengthened.

24.7.9 Limits of Mathematical Transfer

GRE draws on mathematical resources developed for many other domains. Transfer is often productive because mathematics abstracts structure from its original application. The same abstraction, however, can conceal assumptions that mattered in the source context: continuity, stationarity, conservation, locality, linearity, differentiability, exchangeability, ergodicity, fixed state spaces, well-defined probability measures, or stable composition laws. A receiving-domain application should not inherit these properties simply because the notation is available.

Mathematical transfer is therefore stronger than analogy only when the relevant structural conditions are reconstructed locally. A stochastic process requires a defensible event or state space and probability semantics. A dynamical system requires a meaningful state representation and transformation rule. A field model requires some distributed quantity or operator whose variation across position is

interpretable. Category-theoretic composition requires typed morphisms whose composition represents a meaningful composition in the target problem. A topological construction requires locally justified notions of neighborhood, continuity, or adjacency if those concepts do substantive work.

Definition 24.155 (Mathematical transfer dossier). A *mathematical transfer dossier* records the source mathematical structure, receiving GRE objects, preserved axioms or relations, altered or rejected assumptions, local semantic reconstruction, empirical or interpretive bridge, closure conditions, and domain-specific remainder that limits the transferred result.

The dossier supports modular use. GRE need not validate an entire mathematical theory as a model of the economy in order to use one theorem, representation, or structural distinction. The burden concerns the specific transferred result and the assumptions on which it depends.

Proposition 24.156 (Assumption-local mathematical transfer). A *mathematical result imported into GRE supports only those substantive conclusions for which the result's operative assumptions and semantics have been reconstructed in the receiving problem; unused or unjustified source assumptions should not enter the economic interpretation implicitly.*

This proposition makes mathematical pluralism safer. Different formalisms can coexist because each is evaluated locally rather than being promoted to a universal language of GRE.

24.7.10 Observation–Transformation Type Confusion

The project's notation guide preserves a strict distinction between observation or readout and state-changing transformation. This distinction is easy to blur in reflexive systems because observation can become performative. A survey result can trigger policy. A classification can change eligibility. A prediction can alter behavior. A scientific interpretation can reorganize a research field. Yet the fact that an observation participates in a later transformation does not make the observation map itself identical to the transformation.

The type distinction matters formally. A readout maps a modeled configuration into a representation space. A transformation maps one modeled configuration into another, or changes the rules governing later configurations. A performative epistemic event can couple these operations: the readout is interpreted, communicated, institutionalized, or acted upon, and that uptake generates a later transformation. Collapsing the two maps erases where interpretation, authority, decision, or institutional mediation enters.

Definition 24.157 (Observation–transformation type profile). An *observation–transformation type profile* records the modeled configuration being observed, representation produced by the readout, interpretive or institutional uptake, state-changing operation if any, actor or mechanism authorizing that operation, temporal ordering, and evidence that the coupled process altered later configurations.

The profile also prevents an opposite error. Treating observation as always passive can miss classification effects and reflexive feedback. The appropriate model

therefore preserves the type difference while permitting explicit coupling.

Proposition 24.158 (Typed performativity condition). *A GRE model of performative observation should represent the readout and the state-changing operation as distinct typed components unless there is an independently justified formal reason to identify them, while representing the coupling through which the former contributes to the latter.*

This condition keeps epistemic and causal claims separable even when they interact closely.

24.7.11 Limits of 2-Complex Representation

Chapter 15 used 2-complexes as one representation of history-bearing relational configurations. This choice has important advantages. Vertices can represent events or localized configurations, edges can represent relations or transitions, faces can represent higher-order histories or compatibility relations, and labels can carry typed information. The representation is particularly useful when entities are treated as historically extended substructures rather than point-like actors.

The limitation is representational fit. Not every economically relevant relation naturally belongs on an edge, not every higher-order process is well captured by a face, and not every relevant temporal structure is preserved by one incidence architecture. Continuous processes, overlapping memberships, uncertain boundaries, distributed fields, changing relation types, nonlocal constraints, or many-scale processes can require additional structure or another representation entirely. A 2-complex can also over-discretize processes whose relevant variation is continuous or whose event boundaries are analyst-imposed.

Definition 24.159 (2-complex adequacy profile). *A 2-complex adequacy profile records the target historical-relational object, semantics of vertices, edges, faces, labels, and order relations, discretization rule, boundary and scale, information preserved and lost by the representation, alternative representations, and the GRE conclusions that depend specifically on the 2-complex structure.*

The profile should also distinguish representational convenience from ontological commitment. A target can be usefully represented by a 2-complex without being claimed to be fundamentally a 2-complex. Section 24.2 already established this ontological restraint; the present limitation concerns analytical adequacy even before ontology is considered.

Definition 24.160 (2-complex projection remainder). *The 2-complex projection remainder is the target-relevant relational, temporal, material, semantic, or multiscale information not preserved when a historical-relational object is represented through the chosen 2-complex architecture.*

Proposition 24.161 (Representation-plurality condition for 2-complexes). *A GRE result should not depend on 2-complex-specific properties unless those properties are warranted by the target and materially improve the inference relative to serious alternative representations; otherwise the result should be stated at the more representation-invariant level shared across the alternatives.*

This condition keeps the 2-complex available as a powerful tool without allowing

one successful representation to become a mandatory ontology or universal syntax.

24.7.12 Semantics of History Weights and Amplitude-Like Models

History-space formalisms can assign weights to admissible histories in order to represent plausibility, accessibility, support, transition propensity, institutional favoring, or another typed comparative property. Such weights can be analytically useful because GRE often asks how prior events change later possibility structures rather than only which outcome actually occurred. The limitation is semantic underdetermination. A numerical weight has no automatic meaning merely because it is attached to a history.

A nonnegative weight might represent a normalized probability, an unnormalized score, a relative accessibility measure, a calibration device, a decision weight, a model-specific propensity, or a heuristic ranking. These interpretations impose different requirements. Probability requires a justified sample space and probability semantics. Accessibility can remain ordinal or comparative and need not satisfy probability axioms. Decision weights concern choice under a particular decision architecture. A score can organize simulation without any direct empirical interpretation. Conflating these meanings creates false precision.

Definition 24.162 (History-weight semantics profile). A *history-weight semantics profile* records the admissible history set, meaning of the assigned weight, scale or normalization, composition and update rules, evidential or calibration basis, dependence on prior events and constraints, interpretation of zero and relative magnitude, and conclusions that remain valid under alternative admissible weight semantics.

Complex-valued or amplitude-like constructions carry a still greater burden. Interference-like composition, phase, complex summation, or other amplitude structures can be mathematically interesting when they represent a substantive compositional feature that simpler nonnegative weights cannot capture. The use of complex numbers alone, however, does not supply a physical interpretation, empirical probability rule, or quantum ontology.

Definition 24.163 (Amplitude-like model burden). The *amplitude-like model burden* is the additional requirement to specify, beyond the ordinary semantics of history weights, why a complex-valued or amplitude-like construction is needed, what its phase and composition rules mean in the receiving GRE problem, how observable or interpretable consequences are obtained, and what analytical result would be lost under a simpler real-valued representation.

This burden is deliberately demanding. Amplitude-like models may eventually prove useful for representing path interaction, incompatible contextual decompositions, compositional histories, or other structures. At the present stage, such possibilities should remain exploratory unless their added structure earns substantive and evidential interpretation.

Proposition 24.164 (History-weight semantic non-identity). *Similarity among history weights does not establish identity of probability, accessibility, value, causal strength, or physical amplitude unless those meanings and their empirical bridges are independently warranted.*

Definition 24.165 (Formalization revision trigger). A *formalization revision trigger* is evidence or argument showing that a GRE formalism materially mis-types its objects or operations, relies on unidentified parameters, suppresses consequential open-system relations, confuses observation with transformation, fails under serious alternative representations, imports unjustified mathematical assumptions, or assigns stronger semantics to formal quantities than the target warrants.

Formalization therefore remains central to GRE, but not sovereign over it. The appropriate ambition is not to maximize mathematical density. It is to construct representations whose additional structure earns its inferential role and whose limits remain visible. A schematic model can be sufficient when the question is conceptual; a structural model can be sufficient when the relevant object is relational organization; a parameterized model can be warranted when measurement and identification support it; and richer historical, topological, field-theoretic, operator-like, or amplitude-like constructions can be used when they preserve target-relevant distinctions that simpler representations lose. The strongest formal GRE result is consequently one that states not only what follows inside the model, but also why the modeled structure is appropriate, what remains outside it, which empirical bridge supports interpretation, and what evidence would require the formal architecture to change. Section 553 turns to one of the most consequential limits exposed by this discipline: the problem of closure in systems whose relevant relations, rules, and possibility spaces may themselves remain open and historically transformable.

24.8 Closure in Generative Systems

Section 24.7 treated model closure as a formal design decision: some relations are excluded, aggregated, or treated as externally fixed so that a model can become tractable. The present section examines a broader problem. GRE studies processes in which the objects required for description can themselves change. Subjects can emerge or disappear; relation types can be created; institutional boundaries can move; value forms can be recognized or lose force; categories can be reconstituted; and practical action can open or close possibilities that were not available at the beginning of inquiry. The role of this section is therefore to distinguish closure of interactions from closure of the analytical vocabulary and possibility space. Its objective is to clarify when provisional closure is defensible, when higher-order or external dependence defeats it, and how epistemic, institutional, practical, and self-modifying processes should trigger reopening. The method is generative and claim-relative: closure is evaluated by what is being held fixed, for which question, over which boundary and horizon, and whether the supposedly fixed object can itself be transformed by the process under study.

Closure is not inherently a mistake. Inquiry, modelling, institutions, and action all require provisional stabilization. A researcher must decide which actors and relations to investigate; an organization must define membership and authority; a legal system must classify cases; a practical intervention must choose a course of action before every uncertainty is resolved. The problem arises when a local stabilization is interpreted as completeness. A closure adequate for one claim can fail for another, and a closure adequate at one historical moment can be invalidated when the system

Table 24.8: Closure problems in generative systems

Closure mode	What is provisionally stabilized	Principal reopening condition
Higher-order closure	Lower-order relations or correlations	Higher-order structure changes the mechanism or conclusion
Approximate closure	Selected interactions within a boundary and horizon	Excluded variation exceeds the tolerance relevant to the claim
Institutional closure	Membership, jurisdiction, roles, recognized categories, or procedures	Boundary leakage, contested standing, external dependence, or institutional transformation
Epistemic closure	Working concepts, hypotheses, evidence thresholds, or rival explanations	Material anomaly, new evidence, failed prediction, or alternative explanation
Practical closure	A decision or action set under incomplete knowledge	Changed stakes, consequences, feasibility, reversibility, or evidence
Open-system closure	Environmentally coupled system treated as locally analyzable	External flows or feedback become constitutive for the target claim
Self-modifying closure	Actor, relation, type, rule, or possibility sets	The system generates or removes elements of the assumed analytical vocabulary
Research closure	A provisional stopping rule for the inquiry	Accumulated closure debt or a registered revision trigger

generates new relations, categories, or possibilities.

Definition 24.166 (Generative closure profile). A *generative closure profile* records, for a specified GRE inquiry, the actors, relations, relation types, categories, value forms, institutional boundaries, environmental exchanges, admissible transformations, and possibility structures treated as fixed or sufficiently stable; the purpose and horizon of that closure; known excluded dependencies; and the conditions under which the closure must be reopened.

The definition extends the closure remainder of Section 24.7. A closure remainder concerns excluded or weakly represented interactions within a formal model. A generative closure profile asks a stronger question: whether the sets and types over which the model reasons can themselves change. Table 24.8 summarizes the main closure problems developed below.

24.8.1 Higher-Order Correlations

Closure can fail even when the relevant actors and relation types are correctly identified. A model can represent pairwise relations accurately while missing structure that exists only at the level of triads, groups, overlapping memberships, sequences of relations, or relations among relations. Chapter 8 and Section 24.5 already established that higher-order structure should not be introduced merely because it is mathematically available. The present problem is complementary: lower-order closure should not be presumed adequate merely because lower-order relations are easier to observe or model.

Consider a coordination process in which no pair of actors has sufficient incentive to act alone, while a three-party commitment changes the feasible action of all participants. Pairwise ties can be measured correctly and still fail to represent the operative coordination structure. Likewise, two organizations can each have ordinary bilateral relations with a regulator, yet the joint arrangement created by shared standards, cross-appointments, or coupled funding can generate a higher-order institutional constraint. The failure is not simply missing data. It is a mismatch between

the order at which the process is represented and the order at which the relevant dependence exists.

Definition 24.167 (Higher-order closure gap). A *higher-order closure gap* exists when a GRE representation closed at a specified relational order preserves the represented lower-order relations but omits higher-order configurations whose inclusion would materially change the mechanism, attribution, comparison, or practical conclusion.

Higher-order closure should therefore be tested against the target claim. A dyadic representation can remain sufficient for some questions even when higher-order structure exists. The relevant issue is whether the omitted structure changes what the inquiry is trying to establish.

Definition 24.168 (Relational-order sufficiency profile). A *relational-order sufficiency profile* records the lowest relational order used in an analysis, higher-order configurations considered plausible, evidence concerning their presence, conclusions stable under their inclusion, and conclusions that would require a richer representation.

Proposition 24.169 (Claim-relative order closure). A *lower-order GRE representation can be treated as provisionally closed only for claims that remain materially unchanged across serious higher-order specifications compatible with the available evidence.*

The proposition prevents two opposite errors. It avoids assuming that every social or economic phenomenon requires the richest possible higher-order model, while also avoiding the reduction of collective structures to dyads by default. Closure at a given order is earned by invariance of the target conclusion, not by computational convenience alone.

24.8.2 Approximate Closure

Most empirically useful closure is approximate rather than exact. An organization interacts with households, suppliers, regulators, technologies, infrastructures, financial institutions, and cultural environments. A local model can nevertheless isolate a subset of these relations when omitted interactions vary slowly, remain weak for the target question, or affect the result only within an acceptable range. The important issue is to state what *acceptable* means.

Approximate closure is therefore not the claim that external influence is absent. It is the claim that, relative to a specified purpose, boundary, horizon, and level of precision, the omitted variation does not alter the relevant inference enough to defeat its use. The same system can be approximately closed for a short-horizon operational question and radically open for a long-horizon generative question.

Definition 24.170 (Approximate closure profile). An *approximate closure profile* specifies the boundary and horizon of the analysis, interactions represented internally, interactions treated as external or fixed, the claim for which closure is sought, the tolerated effect of excluded variation, evidence supporting that tolerance, and sensitivity results under plausible reopening.

The tolerance should be substantive rather than merely numerical. A small change in an aggregate outcome can be unacceptable if it shifts a burden onto a protected population, removes a critical option, changes a legal status, crosses an ecological threshold, or reverses a qualitative conclusion. Conversely, substantial variation in

an irrelevant dimension need not invalidate the closure.

Definition 24.171 (Closure tolerance). A *closure tolerance* is the largest class of excluded variation that can occur without changing the substantive status of the target GRE claim, including its direction, mechanism, affected subjects, normative relevance, or decision consequence where those dimensions are part of the claim.

Proposition 24.172 (Approximate-closure validity condition). *Approximate closure is warranted only when the excluded variation remains within a claim-relative closure tolerance over the stated boundary and horizon and when plausible departures from that tolerance are identifiable as reopening conditions.*

This formulation makes closure compatible with open systems. It also makes closure revisable. A relation treated as exogenous today can become endogenous after institutional change; an environmental process treated as slow can become decision-relevant after a shock; an omitted actor can acquire veto power; or a previously negligible platform dependency can become central after technical consolidation. Approximate closure is therefore a versioned judgment rather than a permanent property of the target.

24.8.3 Institutional Closure

Institutions create practical boundaries by defining membership, jurisdiction, property, authority, eligibility, recognized roles, valid procedures, and categories of standing. These boundaries can make complex relations governable. A university defines who counts as a student or faculty member; a court defines jurisdiction and admissible claims; a welfare programme defines eligibility; a corporation defines formal membership and authority; a market infrastructure defines recognized instruments and counterparties. Institutional closure is therefore generative: by closing some classificatory and procedural questions, an institution makes coordinated action possible.

The limit is that institutional boundaries are not necessarily identical to the relational boundaries of the phenomenon. Informal caregivers can sustain an institution without formal membership. Supply-chain workers can bear economic consequences outside the legal boundary of a firm. Ecological effects can cross jurisdictions. Platform users can depend on infrastructures whose governing institutions do not recognize them as participants with standing. Institutional closure can therefore organize action while simultaneously externalizing relations that remain causally or normatively material.

Definition 24.173 (Institutional closure regime). An *institutional closure regime* is the historically situated configuration of rules, categories, memberships, jurisdictions, recognized roles, decision procedures, and boundary practices through which an institution determines what is treated as internal, external, authorized, eligible, or cognizable for a specified purpose.

Definition 24.174 (Institutional closure leakage). *Institutional closure leakage* is the set of causally, economically, socially, ecologically, or normatively consequential relations that cross an institutional closure regime while remaining weakly represented, unrecognized, or formally external to the institution's operative categories.

Leakage does not make institutional closure illegitimate by itself. Any organization requires boundaries. The analytical task is to distinguish boundary functionality from boundary adequacy. A boundary can be administratively necessary while still generating externalities, invisibility, or contested standing that require another analytical layer.

Proposition 24.175 (Institutional closure non-completion). *The existence of a stable institutional boundary, category, or jurisdiction should not be interpreted by GRE as evidence that the economically or relationally relevant system is correspondingly closed.*

The proposition also protects the distinction between institutional and ontological closure developed earlier in the book. A working institutional category can be indispensable for coordination while remaining provisional as a description of the underlying relational configuration.

24.8.4 Epistemic Closure

Inquiry cannot remain indefinitely open to every concept, hypothesis, category, and rival explanation. Research requires provisional stabilization of questions, evidence standards, measurement rules, interpretive frames, and stopping conditions. Chapter 6 described the contradiction between provisional epistemic closure and revisability. Chapter 24 now treats that contradiction as a limitation problem: closure permits cumulative inquiry, but it can also suppress alternatives prematurely and make inherited categories self-confirming.

Epistemic closure can occur at several levels. A field can stabilize a vocabulary; a project can fix an operational definition; a statistical analysis can define an estimand; a historical inquiry can delimit a reconstruction range; or an interdisciplinary team can agree that certain premises will be taken as given. None of these choices implies finality. The problem is whether the closure remains visible as a methodological commitment and whether evidence capable of reopening it is still admissible.

Definition 24.176 (Epistemic closure state). *An epistemic closure state is a provisional research configuration in which specified concepts, hypotheses, categories, evidential thresholds, or explanatory alternatives are stabilized sufficiently for cumulative inquiry, while their grounds, excluded alternatives, and reopening conditions remain recorded.*

Definition 24.177 (Epistemic reopening trigger). *An epistemic reopening trigger is evidence or argument that materially challenges a stabilized assumption, reveals a relevant excluded alternative, changes the interpretation of key evidence, exposes category failure, or shows that the current closure suppresses a distinction necessary for the target claim.*

A research programme can become epistemically brittle when its core concepts absorb anomalies by re-description rather than permitting them to count against the framework. The limitation is especially serious for GRE because relational and generative vocabulary is flexible. Almost any process can be redescribed as involving relations or generation at some level. Closure discipline must therefore work together with the failure conditions developed later in this chapter.

Proposition 24.178 (Reopenable epistemic closure). *Epistemic closure strengthens*

GRE only when it reduces the active hypothesis space for a stated purpose while preserving identifiable evidence and arguments capable of reopening the stabilized concepts, categories, or explanations.

This proposition prevents openness from becoming indefinite skepticism and closure from becoming doctrinal immunity. The appropriate balance is a research configuration that can proceed decisively while retaining structured routes for correction.

24.8.5 Practical Closure

Application-dominant praxis adds a distinct closure requirement. Decisions often cannot wait for epistemic completion. Governments adopt temporary measures, organizations allocate resources, clinicians choose interventions, researchers terminate data collection, communities act under threat, and institutions commit to infrastructures whose effects unfold before uncertainty disappears. Practical closure is the stabilization required to act.

Practical closure must therefore be distinguished from epistemic closure. A decision can be provisionally warranted while the underlying explanation remains contested. Conversely, an epistemically well-supported conclusion does not by itself determine which action should be chosen because action also depends on values, rights, distribution, feasibility, reversibility, timing, and institutional authority.

Definition 24.179 (Practical closure profile). A *practical closure profile* records the decision or action being stabilized, the evidence and uncertainties present at the point of commitment, affected subjects, unresolved value conflicts, feasible alternatives, reversibility, monitoring architecture, revision triggers, and the consequences of both action and delay.

A practical closure can be intentionally temporary. Pilot programmes, sunset clauses, staged deployment, reversible defaults, contingency rules, monitoring thresholds, and reserved resources for repair can convert uncertainty into design constraints. This does not eliminate risk, but it prevents action from silently transforming a provisional judgment into irreversible institutional fact.

Definition 24.180 (Closure irreversibility burden). The *closure irreversibility burden* is the additional evidential, participatory, normative, and monitoring burden created when a practical closure removes future options, entrenches dependencies, creates difficult-to-reverse institutions, or redistributes the ability of affected subjects to contest and revise the decision.

Proposition 24.181 (Practical closure non-equivalence). *A justified practical closure should not be interpreted as epistemic completion, normative consensus, or proof that the selected action exhausts the feasible or legitimate alternatives.*

The proposition is central to a generative framework because practical closure changes later possibility. A temporary decision can generate infrastructures, expectations, capabilities, sunk costs, legal entitlements, organizational routines, and dependencies that make reopening progressively harder. Closure therefore has a history: what begins as a reversible decision can become structurally entrenched.

24.8.6 Open Systems

GRE frequently studies open systems. Economic configurations depend on material inputs, ecological conditions, legal environments, information flows, technologies, migration, finance, political authority, cultural meanings, and relations that cross any chosen analytical boundary. Openness does not make analysis impossible. It means that local closure must be justified through the relevance of cross-boundary exchange to the target claim.

The term *open system* can itself become too permissive if every external influence is treated as equally relevant. A system boundary remains analytically useful when it identifies a configuration whose internal relations support a coherent question while external exchanges are explicitly typed. The discipline is therefore neither complete isolation nor boundarylessness, but structured openness.

Definition 24.182 (Open-system exchange profile). An *open-system exchange profile* records the principal material, informational, financial, legal, ecological, technological, human, and symbolic flows crossing a chosen GRE boundary, their direction and temporal scale, the mechanisms through which they affect the focal configuration, and which flows are treated as endogenous, exogenous, or presently unresolved.

Definition 24.183 (Local analytical closure). *Local analytical closure* is a claim-relative condition under which a bounded representation of an open system remains adequate because cross-boundary exchanges omitted or externally specified do not materially alter the target conclusion over the stated horizon and scale.

Local closure can fail through environmental change, policy shifts, infrastructure breakdown, migration, technological substitution, strategic adaptation, or any other process that changes the importance of cross-boundary flows. A model that was adequate before such a change need not remain adequate afterward.

Proposition 24.184 (Open-system closure condition). *GRE may use local analytical closure for an open system when the relevant cross-boundary exchanges are typed, the excluded flows are represented in the closure remainder, and the target conclusion is robust to plausible variation in those flows over the stated horizon.*

This proposition makes open-system reasoning compatible with tractability. It also prevents a boundary choice from erasing the environment on which the focal configuration depends.

24.8.7 Self-Modifying Systems

The strongest closure challenge arises when the system changes not only its state but the categories through which its possible states are described. A market can create a new financial instrument; a legal order can create a new status; a technology can generate a new class of activity; an organization can create a new role; a social movement can produce a new collective subject; an educational system can recognize a new capability; an AI-mediated environment can create forms of coordination or dependence that did not previously exist. In such cases, evolution occurs partly through modification of the analytical vocabulary itself.

This problem should be distinguished from ordinary state change. A fixed-state model allows variables to change within a predetermined space. A self-modifying

generative system can change the variable set, admissible relation types, transition rules, boundary criteria, value categories, or feasible action set. The question is not merely which state follows, but whether the state space used to formulate the question remains adequate.

Definition 24.185 (Type-space closure). *Type-space closure* is the assumption that the classes of subjects, relations, categories, values, institutional roles, or transformations relevant to an analysis remain sufficiently fixed over the stated horizon that new types do not need to be introduced for the target claim.

Definition 24.186 (Possibility-space closure). *Possibility-space closure* is the assumption that the set or generative description of feasible states, actions, institutional forms, or trajectories relevant to an analysis remains sufficiently stable over the stated horizon that materially novel possibilities need not be represented.

Both assumptions can be useful locally. They become problematic when generation itself concerns novelty. A theory of innovation that assumes a fixed set of products can model selection among known alternatives while missing the generation of new product categories. A theory of institutional reform that assumes fixed legal statuses can model redistribution within the existing order while missing status creation. A theory of participation that assumes fixed subjects can miss the emergence of new collective actors.

Definition 24.187 (Generative closure failure). A *generative closure failure* occurs when a process generates, removes, or materially reconstitutes subjects, relation types, categories, value forms, rules, boundaries, or feasible possibilities that were treated as fixed, and the resulting novelty changes the explanatory or practical conclusion.

Self-modification can also alter the rules by which later modification occurs. New technologies can change the speed of coordination; new law can change who has authority to create subsequent law; new infrastructures can change the cost of forming relations; new AI systems can alter knowledge production and hence the conditions under which later technologies are generated. Such processes create second-order generativity: generation changes the generative mechanism.

Definition 24.188 (Generative-rule modification). *Generative-rule modification* occurs when a historical process changes the mechanisms, constraints, admissible transformations, or selection conditions that govern how later subjects, relations, categories, institutions, values, or possibilities can be generated.

Proposition 24.189 (Self-modifying closure constraint). *Where type-space closure, possibility-space closure, or the operative generative rules are themselves materially transformed, GRE should treat the original closure as historically local and reconstitute the analytical space before extending conclusions across the transformation.*

This proposition places a limit on fixed state-space modelling without rejecting it. Fixed spaces can remain powerful approximations within periods of relative stability. The limitation arises when the phenomenon of interest is precisely the production of new dimensions, types, rules, or possibilities.

24.8.8 Closure as Research Problem

The preceding subsections suggest that closure should become an explicit object of GRE research rather than a hidden prerequisite. Every inquiry closes some questions provisionally. The relevant task is to determine which closures are necessary, which are harmless for the target claim, which generate systematic blind spots, and which are themselves changed by the process under investigation.

Definition 24.190 (Closure audit). A *closure audit* is a structured examination of an inquiry's relational order, system boundary, temporal horizon, institutional boundary, epistemic stopping rules, practical commitments, environmental exchanges, type space, possibility space, generative rules, and reopening conditions, together with the conclusions that depend materially on each closure.

The audit is not a demand to reopen everything simultaneously. Complete openness would make cumulative inquiry and practical coordination impossible. Its purpose is to make selective stabilization inspectable and to identify where closure carries the greatest risk of distorting the target.

Definition 24.191 (Closure debt). *Closure debt* is the accumulated research liability created when provisional closures continue to support later claims after their original justification, boundary, horizon, or reopening conditions have become unclear, outdated, or untested.

Closure debt can accumulate gradually. A simplified category becomes standard; later datasets inherit it; models are calibrated to those data; policies use the resulting outputs; and subsequent research treats the category as an empirical fact because it appears consistently across the accumulated evidence. The resulting stability can be produced partly by repeated closure rather than by stability of the underlying phenomenon.

Definition 24.192 (Closure revision trigger). A *closure revision trigger* is evidence or analysis showing that a higher-order configuration, excluded interaction, institutional leakage, epistemic anomaly, practical consequence, cross-boundary exchange, newly generated type, changed possibility space, or modified generative rule materially affects a conclusion that depended on the previous closure.

Proposition 24.193 (Reopenable closure principle). *GRE should prefer the least expansive closure sufficient for the target question while preserving explicit reopening conditions for dimensions whose excluded variation could materially alter the conclusion.*

The principle is deliberately asymmetric. It does not require maximal openness. It requires that closure do no more work than its evidence can support. A narrow local model can therefore be stronger than an apparently comprehensive model when its boundary, horizon, and reopening conditions are better justified.

Closure also provides a useful research agenda. Empirical work can test whether conclusions survive reopening at higher relational order, across wider institutional or ecological boundaries, under alternative categories, or after newly generated possibilities are introduced. Historical work can examine when once-adequate closures failed as institutions or technologies changed. Formal work can develop representations in which actor sets, relation types, or state spaces can expand. Comparative

work can identify domains in which approximate closure is reliable and domains in which self-modification makes closure especially fragile.

The closure problem therefore returns GRE to one of its defining concerns: generation changes the conditions of later generation. A framework designed to study such processes cannot assume globally fixed subjects, relations, categories, values, institutions, or possibility spaces without qualification. It can close them locally, approximately, and provisionally when the target question permits. The theoretical obligation is to record what has been closed, why that closure is useful, what remains outside it, and what would require reopening.

The next section turns to value-theoretical limits. Having clarified when the analytical field itself can be provisionally stabilized, the chapter can ask a different question: whether GRE can reliably identify and distinguish the value forms operating within that field, especially where intrinsic, instrumental, relational, generative, future, and conflicting values resist a single taxonomy.

24.9 Value-Theoretical Limits

The book's value architecture has deliberately resisted a single measure of economic significance. Earlier chapters distinguished situated value attribution, heterogeneous value forms, relational and generative processes, conversion, circulation, recognition, conflict, future consequence, and historically revisable value taxonomies. The role of the present section is not to repeat that architecture but to identify its limits. Its objective is to specify where value forms can be responsibly identified, where familiar distinctions such as intrinsic and instrumental value remain ambiguous, where generative and relational value claims require additional warrants, how future value and conflict enlarge uncertainty, and why the GRE value taxonomy must remain open to expansion, contraction, retyping, and domain-specific correction. The method is diagnostic and claim-relative. A value claim is examined through its bearer, valuing position, evaluative standpoint, realization conditions, temporal horizon, manifestation and recognition regime, comparison rule, and the evidence that would distinguish it from rival value descriptions.

Value theory creates a special difficulty for GRE because the vocabulary of value operates simultaneously at descriptive, interpretive, institutional, and normative levels. A price is an observable economic representation. A legally recognized entitlement can confer practical standing. A community can regard a practice as worth preserving. An analyst can infer that a capability expands later possibilities. A moral theory can claim that a condition is valuable independently of whether anyone presently recognizes it. These statements do not have the same warrant merely because each uses the language of value. The first limitation is therefore semantic and epistemic: GRE must state what kind of value claim is being made before asking how that value is generated, converted, circulated, protected, or lost.

Definition 24.194 (Value-claim profile). A *value-claim profile* records, for a specified GRE claim, the object or condition treated as value-bearing, the valuing or affected positions, the evaluative standpoint, the asserted value form, the mode of realization or recognition, the temporal horizon, the relevant comparison or non-comparison

Table 24.9: Value-theoretical limits in GRE

Limit	Principal risk	Required discipline
Value-form identifica- tion	One manifestation or conse- quence is mistaken for a distinct form of value	Compare realization conditions, bearers, warrants, and rival classifications
Value relation	Final, intrinsic, instrumental, en- abling, and constitutive relations are collapsed	State the evaluative relation and avoid inferring in- trinsic status from non-market or non-instrumental use
Generative value	Generation is equated with good- ness or socially desirable expan- sion	Separate generated consequence from the evalua- tive rule applied to it
Relational value	Any relation-dependent effect is called relational value	Specify whether value lies in, through, because of, or normatively within the relation
Future value	Long-horizon significance is as- serted beyond evidential reach	State horizon, uncertainty, inheritance, option, and discounting assumptions
Value conflict	A practical settlement is mistaken for theoretical resolution	Preserve unresolved claims, burdens, and affected positions after decision
Value plurality	Plurality becomes either forced ag- gregation or unrestricted incom- parability	Localize comparison rules and retain remainders
Value taxonomy	Existing categories become self- confirming or historically frozen	Keep category provenance, anomaly registers, and revision triggers explicit

rule, the evidential basis, and the normative commitments required for the claim.

The profile makes visible several failure points. A value form can be misidentified because a manifestation is mistaken for the underlying value-bearing condition. An instrumental contribution can be confused with value for its own sake. A generative effect can be treated as good merely because it generates more options. A relation can be assigned value because it is persistent even when persistence is burdensome. Future effects can be asserted with confidence unsupported by the horizon of the evidence. A taxonomy can become self-confirming because research instruments detect only the value forms they were designed to represent.

Table 24.9 summarizes the principal value-theoretical limitations developed in this section.

24.9.1 Identification of Value Forms

A value form is useful only if it performs analytical work that would be lost by treating it as another already recognized form. Chapter 14 used material, financial, capability, relational, epistemic, institutional, participatory, option, future, and ecological value as a working taxonomy. Chapter 22 subsequently made the taxonomy explicitly researchable and revisable. The limitation is that the evidence encountered in an inquiry does not arrive already sorted into these categories. Researchers select indicators, interpret practices, infer realization conditions, and decide which distinctions are sufficiently stable to warrant a separate value form.

The presence of a distinctive manifestation is not sufficient. A new index, score, budget category, or institutional label can create a new representation without disclosing a new value form. Likewise, the existence of a different bearer is not sufficient. The same form of value can be instantiated by individuals, organizations, communities, infrastructures, or ecological configurations. A separate value form becomes analytically useful when the conditions of realization, loss, conversion, recognition,

comparison, or conflict differ materially enough that collapsing the cases changes the explanation or evaluation.

Definition 24.195 (Value-form identification dossier). A *value-form identification dossier* records the proposed value form, candidate bearers, realization conditions, characteristic manifestations, recognition mechanisms, conversion interfaces, relevant temporal horizon, rival classifications, and the explanatory or evaluative distinctions that would be lost if the proposed form were collapsed into an existing category.

Proposition 24.196 (Value-form differentiation condition). A *proposed GRE value form* is warranted only when its differentiation preserves materially relevant realization, conversion, recognition, conflict, temporal, or evaluative structure that would be obscured by the serious alternative classifications available for the inquiry.

The condition is intentionally demanding. It prevents the taxonomy from expanding whenever a researcher encounters a novel object. A new technology can carry material, financial, capability, epistemic, relational, institutional, or future value without requiring a distinct “technology value” category. Conversely, an existing broad category can become inadequate if comparative research repeatedly reveals several realization mechanisms with different incidence, conversion pathways, or normative implications.

Identification is also sensitive to observation and representation. Section 24.4 showed that institutional categories and metrics can create apparent distinctions that are partly artifacts of manifestation regimes. Value-form research must therefore ask whether an observed boundary reflects a difference in value-bearing conditions or merely a difference in how those conditions are measured, administered, or narrated.

Definition 24.197 (Value-form identification uncertainty). *Value-form identification uncertainty* is uncertainty concerning whether an observed pattern warrants a distinct value category, belongs within an existing form, represents a conversion or manifestation of another form, or reflects a classification effect generated by the inquiry or institution itself.

Identification uncertainty does not require suspension of all value analysis. A study can proceed with a provisional category if its status is explicit and if the conclusions do not depend on treating the category as ontologically final or universally portable.

24.9.2 Intrinsic and Instrumental Value

The distinction between intrinsic and instrumental value remains useful, but GRE inherits the ambiguity of the wider value-theoretical vocabulary. Something can be valued as an end, valued independently of a particular consequence, valued because of its internal properties, valued because a relation partly constitutes the good, or valued because it enables another valued condition. These are not equivalent claims. In particular, non-instrumentality does not by itself establish intrinsic value in a stronger relation-independent sense.

GRE therefore treats intrinsic and instrumental descriptions as indexed claims

rather than as universal properties attached once and for all to an object. Money may be instrumental in one analysis; participation may be instrumentally valuable because it improves information and also valued as a constitutive feature of political standing; an ecological condition may be treated as instrumental to production within one economic model while another evaluative framework attributes non-instrumental value to it. The analytical requirement is not to choose one vocabulary globally, but to specify which relation is asserted and whose evaluative framework licenses it.

Definition 24.198 (Value-relation specification). A *value-relation specification* identifies whether a value claim concerns contribution to another end, enabling capacity, constitutive participation in an end, value for its own sake, relation-dependent significance, or another explicitly stated evaluative relation, together with the standpoint and conditions under which the relation is asserted.

Proposition 24.199 (Intrinsic-status non-inference). *The absence of an identified instrumental use, market price, exchange relation, or downstream consequence does not by itself establish intrinsic value; intrinsic or final status requires an independent evaluative warrant appropriate to the domain and claim.*

A symmetrical restraint applies to instrumentality. A condition can contribute causally to another valued outcome without being interchangeable with other means. Trust can support coordination but can also carry relation-specific significance. Education can increase earnings while also constituting capability, social participation, or epistemic standing. Treating these objects as merely instrumental can therefore erase dimensions that matter to the inquiry.

Definition 24.200 (Instrumental non-exhaustion). *Instrumental non-exhaustion* obtains when an object, relation, or condition has an identifiable contribution to another valued end while additional value claims concerning the same object remain materially relevant and are not represented by that contribution.

The resulting limitation is one of classification, not skepticism. GRE can use instrumental analysis strongly where the research question concerns causal contribution. It should simply avoid converting one valid instrumental relation into a complete account of value.

24.9.3 Generative Value

Generative value is central to GRE because economic processes can matter through the later capacities, relations, options, institutions, knowledge, and conditions they help create or preserve. The concept is also unusually vulnerable to overreach. Generation is a descriptive property of a process relative to a specified outcome space; value is an evaluative attribution. A process can generate many later possibilities while generating harmful dependencies, exploitative relations, ecological burdens, or institutional fragility. Conversely, preservation or restraint can be valuable even when it generates few novel options.

The limitation therefore concerns the bridge between generative description and value attribution. Calling an effect “generative value” is defensible only when both parts of the expression are warranted: the relevant effect must be attributable to the

process with appropriate strength, and the generated or preserved condition must have a separately specified evaluative standing.

Definition 24.201 (Generative-value warrant). A *generative-value warrant* combines an empirically or interpretively supported generative attribution with an explicit value claim concerning the generated, preserved, regenerated, or made-accessible condition, including the relevant subjects, horizon, evaluative standpoint, and competing burdens.

Proposition 24.202 (Generativity–goodness separation). *Evidence that a process increases generativity, option production, relational proliferation, institutional capacity, or later transformation does not by itself establish that the generated consequences are desirable, just, welfare-enhancing, or worthy of preservation.*

Generative value also depends on what is counted as generation. A university may generate publications, skills, networks, credentials, organizations, or public knowledge. A platform may generate interactions while degrading autonomy or concentrating control. A policy may create near-term employment while narrowing later ecological possibilities. The choice of generated object can therefore predetermine the apparent value of the process if burdens and foreclosed possibilities are omitted.

Definition 24.203 (Generative-value scope profile). A *generative-value scope profile* records the generated or preserved objects counted in the analysis, affected subjects, positive and negative consequences, foreclosed alternatives, distribution across positions, temporal horizon, and the value rule under which the resulting generative pattern is evaluated.

Proposition 24.204 (Selective-generation warning). *A generative-value assessment is incomplete when it counts generated capacities, options, relations, or outputs that support the favored conclusion while omitting materially connected harms, dependencies, closures, or displaced possibilities produced by the same process.*

The concept should therefore remain narrower than “everything that creates something.” Its analytical advantage lies in tracing how present configurations condition later possibility and capacity, not in assigning automatic normative priority to expansion or novelty.

24.9.4 Relational Value

Relational value has several legitimate but non-equivalent meanings. Value can be *carried by* a relation, as when trust or coordination supports access and capability. Value can be *realized through* a relation, as when collaboration makes an achievement possible. The relation itself can be part of what participants value, as in friendship, care, membership, or shared practice. A normative framework can also evaluate the quality or appropriateness of a relationship. These claims should not be collapsed merely because each is relational.

The limitation is especially important for GRE because the framework already gives relations analytical prominence. Without additional discipline, any valuable object could be redescribed as relational simply because its realization depends on some surrounding relation. Such semantic expansion would make relational value nearly universal and therefore weakly discriminating.

Definition 24.205 (Relational-value mode). A *relational-value mode* specifies whether the value claim concerns a relation as a valued good, a relation as an enabling or constitutive condition of another value, a relational position that changes economic significance, or a normative evaluation of how subjects ought to relate.

Proposition 24.206 (Relational-value discrimination condition). *GRE should describe a value claim as relational only when identifying the relevant relation or relational position adds material explanatory or evaluative discrimination beyond stating that the valued condition occurs within a generally relational environment.*

Relational value can also be negative or mixed. Dependence can provide security and constrain exit. Membership can create solidarity and exclusion. Dense coordination can generate capability and surveillance. Persistent relation-specific assets can support continuity while creating lock-in. The value of a relation should therefore not be inferred from its strength, density, stability, or duration alone.

Definition 24.207 (Relational-value ambivalence profile). A *relational-value ambivalence profile* records the beneficial, harmful, enabling, constraining, constitutive, positional, and distributional dimensions of a relation for materially affected positions rather than assigning one undifferentiated value sign to the relation as a whole.

This profile also limits transfer across contexts. A relational configuration valuable in one institutional setting can become burdensome under another because exit rights, power asymmetries, information, legal protections, or alternative relations change. Relational value is therefore often historically and positionally indexed.

24.9.5 Future Value

Future value is necessary for a generative framework because many economically significant consequences appear only after delay. Education, ecological restoration, scientific infrastructure, institutional capacity, preventive health, maintenance, and option preservation can require present expenditure for uncertain future realization. Yet the further the horizon extends, the more strongly value claims depend on assumptions about future subjects, technologies, institutions, preferences, ecological conditions, discounting, inheritance, and the persistence of conversion pathways.

Future value therefore combines ordinary uncertainty with a problem of future standpoint. Current actors can estimate later consequences, but future subjects may evaluate inherited conditions differently. Some future value claims concern benefits to identifiable later persons; others concern maintaining capacities, ecological conditions, knowledge, institutional options, or possible trajectories whose eventual beneficiaries cannot yet be specified.

Definition 24.208 (Future-value horizon profile). A *future-value horizon profile* records the temporal horizon of a value claim, projected value-bearing conditions, expected beneficiaries or affected positions where identifiable, uncertainty sources, persistence and maintenance assumptions, conversion assumptions, discounting or weighting rules where used, and conditions under which later re-evaluation could revise the present claim.

Proposition 24.209 (Future-value uncertainty condition). *The evidential strength of a future-value claim cannot exceed the warrant for the causal, institutional, ecological,*

technological, and evaluative assumptions required to connect the present configuration to the asserted future significance.

This proposition does not imply that distant consequences should be ignored because they are uncertain. Ignoring them is itself an evaluative and temporal choice. The appropriate response is to distinguish uncertainty from absence and to report which conclusions depend on which future assumptions.

Future value also interacts with option value. Preserving an option can be valuable because later actors retain the ability to choose under improved information. But option expansion is not always beneficial. A large option set can be costly to maintain, strategically manipulated, inaccessible to some positions, or composed largely of undesirable possibilities. The value of optionality therefore depends on practical reachability, affected subjects, maintenance cost, reversibility, and the quality of the alternatives preserved.

Definition 24.210 (Future-value remainder). A *future-value remainder* is a materially relevant long-horizon consequence, affected future position, preserved or foreclosed possibility, or uncertainty that is not captured by the operative present valuation, discounting rule, or decision metric.

Future-value analysis is strongest when it preserves such remainders rather than converting every distant consequence into a single present-equivalent quantity.

24.9.6 Value Conflict

Value conflict arises when economically relevant value claims cannot all be realized, protected, recognized, or prioritized under the available conditions. Conflict can occur among value forms, among subjects, across generations, between local and system-level consequences, or between economic valuation and legal, political, ecological, educational, or other domain-specific evaluative authorities. The limit for GRE is that describing the conflict does not by itself provide the rule for resolving it.

A project can generate employment while damaging an ecological relation. A platform can increase access while weakening privacy or bargaining power. A research programme can generate knowledge while imposing burdens on participants. An institution can preserve continuity for current members while narrowing entry for later participants. GRE can reconstruct these relations, identify affected positions, trace conversion and distribution, and show how power conditions the settlement. Those achievements do not automatically determine which value should prevail.

Definition 24.211 (Value-conflict topology). A *value-conflict topology* records the value claims in conflict, their bearers or affected positions, realization conditions, incompatibilities, available compromises or sequencing options, power over the decision interface, comparison rules used, and value remainders left unresolved by each feasible settlement.

Proposition 24.212 (Conflict-description non-resolution). *A complete relational description of a value conflict does not by itself establish the normatively justified resolution unless the evaluative rule that licenses the resolution is independently warranted.*

Institutional settlement should likewise be distinguished from theoretical resolution. Markets, courts, organizations, elections, expert procedures, community prac-

tices, or administrative rules can produce a decision. The fact that a procedure settles the issue can be economically and politically consequential, yet it does not establish that the competing value claims have become commensurable or that the residual loss has disappeared.

Definition 24.213 (Settlement–resolution gap). The *settlement–resolution gap* is the difference between achieving a practically operative decision concerning conflicting value claims and establishing that the underlying evaluative disagreement, burden, or remainder has been normatively or conceptually resolved.

This gap is essential for later analysis of power and justice. The ability to impose a settlement can determine which value becomes actionable without determining which value is justified.

24.9.7 Value Plurality

Value plurality is one of GRE’s central working commitments, but it too has limits. Plurality can be overstated if every evaluative difference is treated as a distinct value form; it can be understated if all values are forced onto one metric because practical decisions require comparison. The theoretical problem is to distinguish plurality of value-bearing conditions, plurality of evaluative standpoints, plurality of measurement scales, and plurality of normative principles.

These forms of plurality can coincide without being identical. Two groups can disagree about one value while using the same metric. One institution can recognize several value forms under one procedural rule. Several metrics can represent different manifestations of the same underlying concern. A normative dispute can persist even when empirical values are agreed. GRE therefore needs to type the plurality before drawing conclusions about commensurability or conflict.

Definition 24.214 (Value-plurality profile). A *value-plurality profile* distinguishes plurality of value-bearing conditions, value forms, valuing or affected positions, evaluative standpoints, representations, comparison rules, and normative principles within a specified inquiry.

Proposition 24.215 (Plurality non-incommensurability condition). *The presence of multiple value forms or evaluative standpoints does not by itself establish that comparison is impossible; comparability and incommensurability must be localized to a specified operation, purpose, and domain.*

The converse is equally important. The existence of a practical comparison does not prove that the underlying values are equivalent. Budgeting, cost-effectiveness rules, legal damages, voting procedures, rankings, multicriteria methods, and negotiated settlements can all create local commensuration while leaving conceptual, experiential, ecological, or normative remainders.

Definition 24.216 (Plurality-preserving comparison). A *plurality-preserving comparison* is a decision or analytical procedure that makes specified value claims comparable for a bounded purpose while recording the comparison rule, dimensions excluded from it, affected positions, and material remainders not represented by the common decision space.

Value plurality therefore supports neither automatic aggregation nor automatic

refusal to compare. The appropriate position is local: identify the comparison being attempted, the values it preserves, the values it transforms, and the remainders it leaves unresolved. The next section examines this problem directly through heterogeneous value and incommensurability.

24.9.8 Limits of Value Taxonomy

The final limitation concerns the taxonomy itself. A value taxonomy is a research instrument: it organizes inquiry, supports comparison, and helps identify conversion or conflict. It is not a completed inventory of everything that can be valuable. The existing GRE taxonomy emerged from the problems developed in this book, and its usefulness must therefore remain conditional on future historical, comparative, empirical, and cross-domain research.

Taxonomies face at least four risks. First, *category inflation* occurs when every novel object receives a new value label. Second, *category compression* occurs when materially different realization or evaluative structures are merged because one familiar category is convenient. Third, *category lock-in* occurs when data collection and institutions reproduce inherited categories until their persistence is mistaken for naturalness. Fourth, *category export* occurs when a value form developed in one domain is transferred elsewhere without reconstructing its realization and evaluative conditions.

Definition 24.217 (Value-taxonomy adequacy profile). A *value-taxonomy adequacy profile* records which GRE value forms are used in an inquiry, distinctions each form preserves, overlaps among forms, unresolved cases, domain-specific additions or exclusions, observed anomalies, and the conclusions that materially depend on the taxonomy chosen.

Definition 24.218 (Value-taxonomy anomaly). A *value-taxonomy anomaly* is an empirically, interpretively, or normatively relevant value-bearing pattern that cannot be represented adequately within the current taxonomy without systematic ambiguity, loss of discrimination, forced commensuration, or contradiction among category rules.

An anomaly should not automatically produce a new category. It can indicate poor measurement, an unrecognized conversion process, context-specific variation, or an overly broad existing form. Repeated anomalies across independent inquiries nevertheless provide evidence that the taxonomy may require revision.

Definition 24.219 (Value-taxonomy revision trigger). A *value-taxonomy revision trigger* is accumulated evidence that the current taxonomy systematically collapses materially different value structures, proliferates distinctions without explanatory gain, fails to represent recurrent value-bearing conditions, or transports categories across domains in ways that distort the target phenomenon.

Proposition 24.220 (Open value-taxonomy principle). *GRE should treat its value taxonomy as a versioned analytical portfolio whose categories can be retained, subdivided, merged, retyped, localized, or abandoned according to their demonstrated explanatory, empirical, interpretive, and evaluative performance.*

This principle is consistent with the closure discipline of Section 24.8. Value analy-

sis often requires temporary type-space closure so that empirical work can proceed, but generative and historical processes can produce value-bearing conditions that were not captured by the original vocabulary. A fixed taxonomy would therefore be especially problematic in a framework whose substantive object includes the generation and transformation of value itself.

The limits identified in this section do not weaken the case for heterogeneous value. They specify the conditions under which heterogeneous-value analysis remains discriminating rather than merely expansive. Value forms must be identified rather than assumed; intrinsic, instrumental, generative, and relational claims must retain their distinct warrants; future claims must expose their horizon and uncertainty; conflicts must preserve unresolved remainders; and plurality must not be converted either into forced aggregation or into unrestricted incomparability. The taxonomy remains useful precisely because it remains revisable.

The next section narrows the problem to commensurability. Once value forms and evaluative standpoints are treated as plural but revisable, GRE must ask which comparisons can legitimately be constructed across heterogeneous values, where common measures fail, how institutions create local commensuration, and what remains when aggregation is not warranted.

24.10 Heterogeneous Value and Incommensurability

Section 24.9 established that GRE's heterogeneous-value vocabulary must remain typed, revisable, and explicit about the warrants that support different value claims. The present section addresses a narrower but more difficult problem: what follows when several value forms are simultaneously relevant but cannot be represented adequately by one common measure. Its role in Chapter 24 is therefore to specify the limits of comparison itself. The section distinguishes partial commensurability from stronger commensurability, local and institutional commensuration from value identity, forced commensuration from legitimate practical comparison, and translation from measurement. It then develops the idea of residual value and closes by identifying conditions under which aggregation becomes analytically or normatively misleading.

The method is deliberately local. GRE should not label two values simply "commensurable" or "incommensurable" without specifying the operation for which comparison is attempted, the domain and decision context, the affected positions, the comparison rule, and the dimensions that remain outside the comparison. Incommensurability is therefore treated neither as a metaphysical property that automatically attaches to certain value forms nor as an obstacle that disappears whenever an institution produces a decision. The relevant question is which distinctions a proposed comparison preserves, which it transforms, and which it leaves unresolved.

Table 24.10 summarizes the limitation architecture developed in this section.

Table 24.10: Commensurability limits in heterogeneous-value analysis

Problem	Principal risk	Required discipline
Partial commensurability	Bounded comparability is expanded into general equivalence	State the operation, dimensions, horizon, and excluded value claims
Non-commensurability	Local comparison failure is generalized into absolute incomparability	Identify the failed operation and test alternative comparison procedures
Local commensuration	A temporary common scale is mistaken for value identity	Preserve scope, purpose, reversibility, and remainder
Institutional commensuration	Institutional decision rules acquire unwarranted evaluative authority	Separate operative settlement from substantive justification
Forced commensuration	Power-created comparability is treated as neutral measurement	Record coercion, exclusion, burden allocation, and unavailable alternatives
Translation without measure	Interpretive correspondence is confused with quantitative conversion	Preserve semantic asymmetry and non-equivalent dimensions
Residual value	Unrepresented dimensions disappear after decision	Record what remains valuable, harmed, foreclosed, or contested
Aggregation	A scalar result conceals heterogeneity, distribution, or threshold effects	State aggregation rule, weights, losses, and non-aggregable conditions

24.10.1 Partial Commensurability

Comparison among heterogeneous values need not be all-or-nothing. Two value claims can be comparable with respect to one practical question while remaining non-equivalent in other respects. A policy can be compared with alternatives by financial cost while leaving ecological, relational, participatory, or future-value dimensions outside the monetary comparison. Two educational programmes can be compared by completion rates while remaining differently valuable with respect to curiosity, judgment, belonging, or long-run capability generation. Partial commensurability therefore concerns the bounded construction of a common comparison space rather than the discovery of a universal value metric.

Definition 24.221 (Partial-commensurability profile). A *partial-commensurability profile* records the value forms compared, the specific operation for which comparison is possible, the shared dimensions or decision variables, the comparison rule, the temporal and institutional scope, and the value dimensions that remain outside the common comparison space.

The profile matters because the same pair of value claims can be comparable for one purpose and non-comparable for another. Financial cost and ecosystem restoration can be compared for purposes of a budget constraint without thereby establishing that ecosystem value is financially constituted. Capability gains and administrative burden can be jointly considered in programme design without becoming instances of one underlying value substance.

Proposition 24.222 (Operation-relative commensurability condition). *A claim that heterogeneous values are commensurable is warranted only relative to a specified comparison operation whose rule preserves the distinctions required by the inquiry; success of that operation does not establish unrestricted value equivalence.*

Partial commensurability can be analytically valuable because economic and institutional decisions frequently require comparison without requiring a complete ordering of values. The limitation arises when a bounded comparison is silently gener-

alized. A cost threshold, ranking procedure, compensation schedule, or multicriteria score may solve one coordination problem while remaining inadequate for questions of justice, identity, irreversibility, or long-run generativity.

Definition 24.223 (Overextended commensurability). *Overextended commensurability* occurs when a comparison rule justified for a bounded operation is used to infer equivalence, ranking, substitution, or compensation beyond the dimensions, domain, horizon, or affected positions for which the rule was warranted.

The appropriate GRE response is therefore not to avoid comparison, but to preserve the boundary of the comparison. Partial commensurability should remain visible as partial.

24.10.2 Non-Commensurability

Non-commensurability should be stated with similar care. The failure of one metric does not prove that no meaningful comparison is possible. Monetary valuation can fail while ordinal priority, threshold rules, rights constraints, deliberative judgment, or qualitative comparison remains possible. Conversely, the existence of a ranking does not prove that the ranked values share a common measure. A decision-maker can choose one option over another because one crosses a minimum ecological threshold while the other does not, without claiming that ecological integrity has been converted into the same unit as financial return.

Definition 24.224 (Localized noncommensurability). A *localized noncommensurability* states the value forms involved, the comparison or conversion operation that fails, the reason for failure, the relevant domain and decision context, and the alternative forms of comparison that remain available or have also been ruled out.

This definition prevents the language of incommensurability from becoming too strong. Values can fail to admit cardinal conversion while remaining ordinally comparable. They can resist substitution while still admitting threshold comparison. They can be jointly discussed in practical reasoning while remaining irreducible to one scale.

Proposition 24.225 (Non-commensurability localization principle). *GRE should infer non-commensurability only for the operation whose failure has been established; stronger claims of general incomparability require additional argument concerning the other serious comparison procedures available in the inquiry.*

The converse limitation is also important. Researchers can understate non-commensurability by treating every choice as proof of comparison. A choice can arise through authority, habit, deadline, coercion, procedural default, budget constraint, or institutional hierarchy. The fact that action occurred does not establish that the values were rendered substantively commensurable.

Definition 24.226 (Decision without common measure). A *decision without common measure* is a practical selection among alternatives whose operative settlement does not depend on, and therefore does not establish, a common value measure or a substantively justified ordering of the heterogeneous claims at stake.

This distinction extends the settlement–resolution gap introduced in Section 24.9. Practical necessity can close action while leaving the evaluative structure open.

24.10.3 Local Commensuration

Many economic practices construct common measures that are useful precisely because they are local. Budgets, prices, scoring rules, rankings, cost-effectiveness thresholds, compensation formulas, multicriteria matrices, and negotiated exchange ratios can create decision spaces in which otherwise heterogeneous objects become comparable. GRE should study such commensuration as an institutional and relational achievement rather than assume that the common measure reveals an underlying natural equivalence.

Definition 24.227 (Local commensuration). *Local commensuration* is the bounded construction of a common comparison rule for heterogeneous value claims within a specified decision, institution, time horizon, or practical purpose, without presuming that the resulting comparability extends beyond that context.

A local commensuration can be legitimate and useful. Emergency triage may require priority criteria; public budgeting may require common fiscal constraints; organizational planning may require a common scoring procedure. The theoretical requirement is to distinguish the practical function of the common scale from claims about what the underlying values are.

Definition 24.228 (Commensuration scope record). A *commensuration scope record* specifies the purpose of the common measure, the value forms admitted, the dimensions represented, the rule used, the decision-makers and affected positions, the period of validity, the excluded dimensions, and the conditions under which the commensuration should be reopened.

Local commensuration can also become path dependent. Once data systems, funding rules, professional routines, legal standards, or performance indicators are organized around one common measure, subsequent decisions may reproduce the measure because alternatives are costly to express. The result can be mistaken for evidence that the measure is intrinsically appropriate.

Proposition 24.229 (Local commensuration non-identity). *The successful operation and repeated institutional use of a local commensuration rule do not by themselves establish that the values it compares are identical in kind, globally substitutable, or exhaustively represented by the common measure.*

Local commensuration is therefore best treated as a revisable interface. It can coordinate action while retaining the right to ask what its common scale has left out.

24.10.4 Institutional Commensuration

Institutional commensuration differs from merely local comparison because institutions can stabilize a comparison rule, allocate authority to it, and make it consequential for others. Currency, accounting systems, legal damages, standardized testing, insurance categories, credit ratings, procurement rules, and administrative scoring procedures can convert heterogeneous claims into institutionally actionable quantities or ranks. These forms of commensuration can become relationally real even when their evaluative justification remains contested.

Definition 24.230 (Institutional commensuration regime). An *institutional commensuration regime* is a sufficiently stabilized set of rules, categories, representations, au-

thorities, infrastructures, and enforcement or uptake mechanisms through which an institution renders heterogeneous claims comparable for recurring decisions.

Institutional stabilization changes the problem in two ways. First, the measure can become performative. Actors adapt to ratings, categories, prices, compensation schedules, or eligibility scores, thereby increasing the measure's practical importance. Second, the institution can redistribute the burden of translation. Some groups must express their values in the authorized format while others control the format itself.

Definition 24.231 (Commensuration-authority profile). A *commensuration-authority profile* records who defines the institutional comparison rule, who can revise it, who supplies the required representations, who bears losses created by omitted dimensions, which alternatives are recognized, and which actors can contest or exit the regime.

The existence of such authority does not make institutional commensuration illegitimate. It makes the allocation of authority analytically relevant. An institution can require a common measure because recurrent collective action would otherwise be impossible, but the common measure remains subject to evaluation in light of representation quality, participation, distribution, revision access, and residual value.

Proposition 24.232 (Institutional settlement non-validation). *The stability, legality, efficiency, or practical success of an institutional commensuration regime does not by itself validate the substantive value assumptions encoded in its comparison rule.*

This proposition is especially important where institutional metrics become self-confirming. High-stakes measures can shape behavior until the world increasingly resembles the categories used to assess it. GRE should then analyze both the descriptive quality of the commensuration and the relational reality produced by its institutional uptake.

24.10.5 Forced Commensuration

Some common measures are not merely local or institutional; they are imposed under conditions in which affected positions have little ability to reject the comparison frame. Forced commensuration can occur when a decision must be expressed in monetary terms despite non-monetary loss, when eligibility categories erase forms of need, when standardized rankings determine access despite contested criteria, or when a powerful actor defines which dimensions count as evidence. The central issue is not that a common measure exists, but that the terms of comparison are asymmetrically imposed and consequential alternatives are unavailable.

Definition 24.233 (Forced commensuration). *Forced commensuration* is a comparison arrangement in which heterogeneous value claims are required to enter an authorized common measure or ordering under conditions of materially asymmetric control over the rule, representation, exit, or revision of that comparison.

This definition keeps forced commensuration distinct from every mandatory institutional rule. Collective institutions often need binding procedures. The stronger diagnosis requires evidence about control and constrained alternatives, not merely dissatisfaction with the outcome.

Definition 24.234 (Forced-commensuration burden). A *forced-commensuration bur-*

den is the value loss, representational distortion, strategic adaptation, exclusion, uncompensated remainder, or reduced revision capacity borne by an affected position because it must participate through a comparison rule it does not materially control.

Power analysis is therefore inseparable from forced commensuration. A common measure can relocate conflict from the visible decision to the prior question of which values can appear in the decision at all. Actors with greater resources may also be better able to translate their claims into the authorized metric, creating an inequality that appears after commensuration as if it were a neutral difference in score or price.

Proposition 24.235 (Power-sensitive commensuration condition). *Where control over a comparison rule, representation channel, or revision procedure is materially asymmetric, GRE should treat the resulting commensurability as partly constituted by power rather than as neutral evidence of pre-existing value equivalence.*

Forced commensuration can still yield necessary decisions. The analytical requirement is to preserve how the decision space was constituted and who bore the translation cost.

24.10.6 Translation without Common Measure

Heterogeneous values can sometimes be related without being measured in one unit. Translation can establish intelligible correspondence, practical implications, conditional dependencies, or mutually relevant constraints while preserving semantic difference. An ecological loss can be translated into implications for livelihood, institutional resilience, cultural practice, or future capability without asserting that these effects exhaust ecological value. A legal right can be translated into economic constraints and opportunities without converting the right itself into an economic quantity.

Definition 24.236 (Non-metric value translation). *Non-metric value translation* is a mapping between heterogeneous value descriptions that preserves specified relations, implications, or constraints without requiring a shared cardinal unit, exhaustive substitution rule, or claim of value identity.

Translation therefore has a different burden from commensuration. It must identify which semantic or causal relation is preserved and which aspects remain non-equivalent. A translation can be useful even when it is asymmetric: one domain may be able to express an implication of another without the reverse mapping preserving the same information.

Definition 24.237 (Translation-without-measure profile). *A translation-without-measure profile* records the source and target value descriptions, the relation preserved by translation, directionality, information loss, context dependence, non-equivalent dimensions, and the conclusions that may and may not travel through the mapping.

This profile connects directly to the cross-domain discipline of Chapter 23. Translation is strongest when it remains typed. Treating a translation as a conversion into one common value substance would erase the very heterogeneity that made translation necessary.

Proposition 24.238 (Translation non-equivalence principle). *A successful translation*

between heterogeneous value descriptions establishes the specified correspondence carried by the mapping; it does not by itself establish commensurability, substitutability, or equivalence of the translated values.

Translation without common measure therefore enlarges the space of possible reasoning. GRE need not choose between scalar aggregation and complete silence. It can compare relations, consequences, thresholds, incompatibilities, and conversion conditions while retaining value heterogeneity.

24.10.7 Residual Value

Every bounded commensuration risks leaving something outside the common measure. The omitted dimension can be normatively minor, or it can be central to the affected position. GRE requires a vocabulary for what remains after comparison, translation, conversion, compensation, or settlement. *Residual value* names this remainder without assuming in advance that the remainder is intrinsically valuable, normatively overriding, or impossible to represent by some future method.

Definition 24.239 (Residual value). *Residual value* is a value-bearing dimension, claim, realization condition, affected position, or future possibility that remains materially relevant after a specified comparison, commensuration, translation, conversion, compensation, or aggregation has been performed but is not adequately represented by that operation.

Residual value differs from simple measurement error. The remainder can arise because the common operation was intentionally narrow, because the relevant value lacks the required representation, because the comparison rule excludes certain bearers, or because the value relation is transformed when forced into the authorized metric.

Definition 24.240 (Residual-value ledger). A *residual-value ledger* records the operation that generated the remainder, the omitted or transformed value dimensions, affected positions, whether the remainder is recoverable or irreversible, whether it can be addressed by another procedure, and whether subsequent decisions depend on treating the remainder as negligible.

Residual value is particularly important for compensation. A financial payment can compensate some consequences of loss without restoring the relation, place, capability, option, ecological configuration, or institutional standing that was lost. The issue is not that compensation is meaningless; it is that compensation should not be redescribed as restoration unless the relevant value-bearing conditions are actually restored.

Proposition 24.241 (Compensation non-exhaustion condition). *Where a compensation rule represents only part of the value structure affected by a loss, successful payment or settlement should be interpreted as resolution of the represented claim rather than as evidence that the full value loss has been extinguished.*

A residual-value ledger can therefore preserve unresolved burdens after a decision has become final. This matters for historical learning because later research may reveal that what earlier procedures treated as negligible was structurally important.

24.10.8 Limits of Aggregation

Aggregation is attractive because it converts plural information into a form that can support ranking, optimization, budgeting, comparison, or monitoring. GRE does not reject aggregation. It asks what must be true for aggregation to preserve the distinctions relevant to the claim being made. The answer depends on the value forms, the distribution of gains and losses, thresholds, irreversibilities, temporal horizons, and the authority assigned to weights or trade-offs.

Definition 24.242 (Value-aggregation warrant). A *value-aggregation warrant* specifies the value forms included, the aggregation purpose, normalization and weighting rules, treatment of distribution and affected positions, temporal horizon, substitutability assumptions, thresholds or veto conditions, uncertainty, residual value, and the interpretation licensed for the aggregate result.

The same data can support different aggregates because weighting is not purely mechanical. Weights can encode empirical frequency, institutional priority, preference, political compromise, normative judgment, or convenience. GRE should therefore avoid presenting a weighted index as if the weighting scheme were merely discovered in the data when it contains substantive choices.

Definition 24.243 (Aggregation-loss profile). An *aggregation-loss profile* records which distinctions among value forms, bearers, distributions, thresholds, histories, and uncertainties disappear when a set of heterogeneous value claims is reduced to an aggregate representation.

Some losses can be acceptable for the intended purpose. A dashboard may legitimately summarize many dimensions for monitoring while retaining disaggregated records for diagnosis. Other losses are disqualifying. Aggregation can conceal that one group bears an irreversible loss while another receives a compensating gain, that a minimum threshold is violated, or that one value is non-substitutable within the decision rule.

Proposition 24.244 (Aggregation adequacy condition). An *aggregate representation* is adequate for a GRE claim only when the distinctions removed by aggregation are immaterial to that claim or are preserved through explicit constraints, disaggregation, thresholds, sensitivity analysis, or residual-value accounting.

This condition yields a practical limit. Not every heterogeneous-value problem should culminate in a single index. In some inquiries, a partially ordered set of alternatives, a threshold structure, a vector of retained values, a portfolio of scenarios, or a documented unresolved conflict can be more informative than a scalar optimum. Formal simplicity should not be purchased by erasing the object of interest.

Definition 24.245 (Non-aggregable decision condition). A *non-aggregable decision condition* obtains when every serious proposed aggregate would erase a distinction that is constitutive of the decision's evaluative, distributive, threshold, rights-based, irreversible, or historically specific structure, and no defensible correction preserves that distinction within the aggregate representation.

Non-aggregability does not eliminate the need to act. It changes the appropriate decision architecture. Deliberation, sequencing, threshold rules, constrained optimization, multiple criteria, rights constraints, negotiated settlement, or explicit political

judgment may still produce action. What GRE should resist is the retrospective claim that action proves the existence of a complete common value measure.

The limitation developed across this section can be summarized as follows. Heterogeneous value does not entail unrestricted incommensurability, and practical comparison does not entail value identity. Commensuration is often local, institutionally constructed, and sometimes power-laden. Translation can proceed without a common measure. Decisions can leave residual value, and aggregation can support analysis only when its losses remain compatible with the claim being made. GRE should therefore treat commensurability as an operation-relative and revisable achievement rather than as a universal property of value.

The next section turns from comparison to transformation. Even when values can be identified and compared adequately, GRE still faces open questions concerning when one value form can be converted into another, what is lost or gained at conversion interfaces, when conversion is irreversible or power-laden, and how conversion can be identified empirically without presuming equivalence.

24.11 Open Problems of Value Conversion

Sections 24.9 and 24.10 clarified the limits of value taxonomy, comparison, commensuration, and aggregation. The present section turns to a different difficulty: even when a source value form and a target value form can be described coherently, it can remain uncertain whether a genuine conversion process connects them. Its role in Chapter 24 is therefore to identify the unresolved conditions under which GRE can attribute value conversion rather than mere co-occurrence, transfer, circulation, reclassification, common-cause change, or parallel generation. The section examines conversion conditions, interfaces, loss and gain, irreversibility, failure, power, non-equivalent conversion, and empirical identification. The method is mechanism-oriented and explicitly comparative. A conversion claim should become stronger only when the proposed source–target transformation survives serious rival explanations and when the interface through which the transformation occurs is sufficiently reconstructed for the research question at hand.

The underlying difficulty is structural. GRE defines conversion as a typed transformation in which a value-bearing condition represented in one form, register, or domain becomes realizable, legible, actionable, or institutionally effective in another. The definition is intentionally broader than monetary exchange and intentionally weaker than value equivalence. That breadth creates analytical reach, but it also creates a risk of conceptual over-attribution. If every change in practical significance is called conversion, the concept loses its capacity to discriminate among mechanisms. The open problem is therefore not merely how to describe more kinds of conversion, but how to determine when conversion is the best-supported explanation of an observed transformation.

Table 24.11 summarizes the limitation architecture developed in this section.

Table 24.11: Open problems in value-conversion analysis

Problem	Principal identification risk	Required GRE discipline
Conversion conditions	Source possession is confused with effective convertibility	Distinguish constitutive, enabling, complementary, threshold, and constraining conditions
Conversion interfaces	A complex transformation is attributed to an unspecified black box	Reconstruct the materially relevant interface functions and alternative pathways
Conversion loss	Any source–target difference is re-described as conversion loss	Attribute loss to the conversion mechanism and preserve heterogeneous remainders
Conversion gain	Target improvement is treated as proof that conversion generated the gain	Separate conversion-generated gain from transfer, redistribution, co-generation, and relabeling
Irreversibility	High reversal cost is confused with structural non-recoverability	Specify what cannot be recovered, by which reverse path, over what horizon, and why
Conversion failure	Heterogeneous unsuccessful episodes are pooled into one category	Localize failure to entry, interface, target realization, durability, or source–target specification
Conversion under power	Interface rules are treated as neutral technical conditions	Identify control over admission, terms, recognition, alternatives, appeal, and revision
Conversion without equivalence	Transformation is interpreted as common value substance	Preserve typed source and target forms and non-equivalent remainders
Empirical identification	Correlated source and target changes are treated as conversion	Require provenance, process evidence, rival-mechanism tests, and negative or contrastive evidence

24.11.1 Conversion Conditions

A source value form is not automatically convertible into a target form. Knowledge does not become recognized qualification solely because knowledge exists; financial resources do not become health capability without access, infrastructure, time, information, and suitable services; ecological significance does not become legally protected status without relevant institutions; and social recognition does not become enforceable entitlement merely because it is widely expressed. Conversion therefore depends on a condition architecture rather than on a source quantity alone.

Definition 24.246 (Conversion-condition architecture). *A conversion-condition architecture records the conditions that materially determine whether a specified source value form can become effective in a specified target form through a specified interface, distinguishing at least constitutive, enabling, complementary, threshold, constraining, temporal, and position-specific conditions where those distinctions affect the explanation.*

The distinction among condition types matters. A constitutive condition helps define what the conversion is; an enabling condition makes an otherwise defined conversion practically possible; a complementary condition must be combined with the source; a threshold condition determines admissibility or activation; and a constraining condition narrows the domain, rate, timing, or target form. The same empirical feature can occupy different roles in different conversion architectures. Legal status can be constitutive of one institutional conversion, merely enabling in another, and irrelevant in a third.

Proposition 24.247 (Conditional convertibility principle). *GRE should attribute convertibility to a source position only relative to a specified target, interface, and materially relevant condition architecture; possession of the source form alone does not establish effective conversion capacity.*

An additional open problem arises because conversion conditions can themselves be historically generated by earlier conversions. A credential can become a condition for employment because prior institutional processes established credentialing as a recognized interface. Financial collateral can become a condition for credit because legal and organizational arrangements stabilize the relevant recognition regime. Conversion analysis can therefore become recursively historical: the conditions that explain a present conversion may be outputs of earlier conversion and institutionalization processes.

Definition 24.248 (Endogenous conversion condition). An *endogenous conversion condition* is a materially relevant condition of a conversion process whose availability, meaning, or distribution is itself produced or transformed by the relational system under analysis.

Endogeneity does not make analysis impossible, but it limits static interpretation. A condition profile should state whether the relevant conditions are being treated as fixed for the local inquiry or whether their generation is part of the mechanism that must be explained.

24.11.2 Conversion Interfaces

Conversion interfaces are the arrangements through which a typed transformation becomes possible. Earlier chapters treated markets, courts, credentialing systems, platforms, banks, standards, schools, organizational routines, translation practices, ecological processes, and interpersonal relations as possible interfaces. The open problem is that an interface can become an explanatory black box if the analysis names the institution without reconstructing the function through which source significance becomes target effectiveness.

Definition 24.249 (Conversion-interface reconstruction). A *conversion-interface reconstruction* identifies the materially relevant functions through which an interface changes the feasibility, form, recognition, timing, burden, or durability of a specified source–target transformation, together with the actors, rules, technologies, representations, and complementary conditions through which those functions operate.

Interface reconstruction should remain proportional to the claim. A narrow administrative question may require only an eligibility rule and processing sequence. A claim about persistent dependence may require a richer reconstruction of gatekeeping, classification, appeals, alternative pathways, technical interoperability, pricing, and historical rule formation.

A second difficulty is *interface multiplicity*. Several distinct interfaces may connect the same source and target. Knowledge can become occupational eligibility through formal degrees, professional examinations, portfolios, apprenticeship, prior work, or employer-specific assessment. If one pathway is studied in isolation, the analysis can mistakenly attribute necessity to an institution that is merely one historically dominant route.

Definition 24.250 (Interface-necessity burden). The *interface-necessity burden* is the evidential requirement for claiming that a specified interface, rather than one of several feasible alternatives, is necessary or uniquely explanatory for the target conver-

sion within the defined domain and period.

The converse problem also occurs. An apparently singular interface may actually compose several nested interfaces. A financing decision can involve legal identity, credit scoring, collateral recognition, risk classification, pricing, documentation, and settlement infrastructure. An observed conversion outcome can therefore depend on a sequence of filters rather than one point of passage.

Definition 24.251 (Composite conversion interface). A *composite conversion interface* is a conversion architecture in which successful target realization depends on two or more materially distinct interface stages whose ordering, interaction, or cumulative burdens affect conversion feasibility or incidence.

GRE should decompose a composite interface when different stages support different causal, distributive, or power claims. Otherwise the language of an interface can conceal the very mechanism the concept was introduced to identify.

24.11.3 Conversion Loss

Conversion loss is analytically meaningful only when the loss can be attributed to the conversion process or to conditions inseparable from its operative architecture. A difference between source and target is not by itself evidence of loss. Some dimensions can simply be irrelevant to the target, preserved outside it, or transformed into a different manifestation. Other losses may arise from background deterioration, transfer to another position, measurement compression, or an independent contemporaneous process.

Definition 24.252 (Conversion-loss attribution). A *conversion-loss attribution* identifies a source-side or relational dimension that becomes destroyed, inaccessible, weakened, excluded, transferred, or materially harder to recover through the specified conversion process, and distinguishes that mechanism from serious alternative explanations of the observed loss.

This definition strengthens the earlier idea of a conversion remainder. A remainder records what does not survive or become represented in the target; a loss attribution adds the stronger claim that the conversion mechanism materially contributed to that disappearance or degradation. The distinction matters because not every remainder is harmful and not every harm is conversion-induced.

Definition 24.253 (Conversion-loss incidence profile). A *conversion-loss incidence profile* records which value-bearing dimensions are lost or weakened, which positions bear the loss, when the loss occurs, whether the loss is recoverable, and whether another position captures or retains what the affected position loses.

The last element prevents dissipation, redistribution, and capture from being collapsed. If a community loses control over a resource because another actor acquires control, the process is not adequately described as mere disappearance. If a standardized representation omits tacit knowledge while the original practice remains viable elsewhere, representational loss need not equal destruction of the source practice. If ecosystem degradation finances a target-side gain, ecological loss and financial gain should remain separately traced rather than netted into one scalar without further warrant.

Proposition 24.254 (Loss non-netting condition). *Where conversion loss and conversion gain concern heterogeneous value forms, different affected positions, or different temporal horizons, GRE should record them separately unless an independently warranted comparison rule justifies aggregation for the specific claim.*

24.11.4 Conversion Gain

Conversion gain presents the mirror-image attribution problem. A target-side improvement can follow a conversion episode without being generated by the conversion mechanism. The target may improve because complementary resources were introduced at the same time, because a third process generated the outcome, because value was transferred from another position, or because the target was reclassified rather than substantively changed.

Definition 24.255 (Conversion-gain attribution). *A conversion-gain attribution identifies a target-side value-bearing capacity, right, option, recognition, relation, or other economically significant condition whose realization or amplification is materially explained by the specified conversion process after serious alternative sources of the gain have been considered.*

Conversion gain therefore differs from conversion success. A successful conversion establishes that the specified target condition has been realized to the relevant threshold. A conversion-gain claim additionally asserts that some target-side value increased or emerged through the process. A legal recognition can successfully convert a claim into enforceable status without producing the broader social or economic gains expected from that recognition. Conversely, an unsuccessful formal conversion can sometimes stimulate learning or organization that generates value through another pathway.

Definition 24.256 (Target-side co-generation). *Target-side co-generation occurs when the target outcome attributed to conversion is jointly produced by the conversion process and one or more complementary generative mechanisms whose contribution is analytically material.*

Co-generation is likely to be common rather than exceptional. Education can convert learning into credentials while peer relations, mentoring, institutional reputation, and labor-market conditions jointly generate the eventual employment outcome. A research publication can convert inquiry into recognized scholarly output while networks, journal prestige, language, timing, and institutional affiliation affect later opportunities. Conversion analysis should therefore resist both extremes: denying conversion because multiple causes are present, and attributing the entire target gain to conversion simply because conversion is one necessary step.

Proposition 24.257 (Gain decomposition principle). *Where target-side gain is plausibly co-generated, GRE should distinguish the contribution of the conversion process from complementary generation, redistribution, background change, and representational reclassification to the degree required by the research question.*

24.11.5 Irreversibility

Irreversibility is especially vulnerable to overstatement. A conversion can be difficult, costly, slow, institutionally blocked, or politically unlikely to reverse without being structurally irreversible. Conversely, an apparent technical reversal can fail to restore lost relations, options, ecological conditions, rights, or historical position. GRE therefore needs a typed account of what reversal would mean.

Definition 24.258 (Conversion-reversal specification). A *conversion-reversal specification* states the source dimensions expected to be recovered, the proposed reverse interface, the required conditions, the temporal horizon, the acceptable reconstruction tolerance, and the dimensions that are not expected to return even if the target is converted into a source-like form.

This specification distinguishes several forms of irreversibility. *Material irreversibility* concerns physical or ecological states that cannot be practically reconstructed. *Institutional irreversibility* concerns rights, classifications, commitments, or infrastructures whose reversal is blocked or substantially path-dependent. *Relational irreversibility* concerns trust, membership, reputation, dependence, or other relations that are not restored merely by reversing the nominal transaction. *Option irreversibility* concerns foreclosed alternatives. *Historical irreversibility* concerns the simple fact that the original temporal position cannot be recreated after the sequence has occurred.

Definition 24.259 (Conversion irreversibility profile). A *conversion irreversibility profile* identifies which dimensions of a conversion episode are non-recoverable, costly to recover, delayed, path-dependent, or reconstructable only approximately, and states the evidence supporting each classification.

The profile avoids a binary reversible–irreversible label where different dimensions behave differently. Financial compensation may reverse a monetary transfer while leaving ecological damage, lost time, disrupted identity, or institutional dependence substantially unrecovered. A reverse credentialing process may revoke formal status without restoring the opportunity set that existed before the original credential altered a career path.

Proposition 24.260 (Irreversibility localization principle). A *conversion should be described as irreversible only with respect to the dimensions, reverse pathway, reconstruction tolerance, and horizon for which non-recoverability has been established; practical difficulty alone does not justify a stronger claim.*

24.11.6 Conversion Failure

Failed conversion is informative only when failure is localized. An unsuccessful episode can fail before entry, at validation, during transformation, at target realization, after nominal realization, or during persistence. These failures imply different mechanisms and different interventions.

Definition 24.261 (Conversion-failure locality). *Conversion-failure locality* identifies the stage at which a specified conversion attempt ceases to satisfy the conditions required for target realization, distinguishing at least source admissibility, interface access, validation, transformation, target realization, target durability, and later us-

ability where those stages are analytically material.

A failed university application and a degree that does not produce occupational recognition are both unsuccessful conversion episodes in a broad sense, but they fail at different interfaces and target conditions. A benefit may be formally awarded while inaccessible in practice. A platform may approve monetization while actual revenue remains negligible. These cases justify preserving the distinction between formal completion and substantive target realization.

Definition 24.262 (Durability failure). A *durability failure* occurs when the target condition is initially realized but cannot be sustained for the period, use, or relational function specified by the research question because the conversion architecture does not reproduce the conditions required for persistence.

Failure can also challenge the source–target specification itself. Repeated failures across otherwise favorable condition sets may indicate that the proposed source is not actually convertible into the stated target, that the interface has been misidentified, or that the target category bundles several different outcomes.

Definition 24.263 (Conversion-model falsification pressure). *Conversion-model falsification pressure* is the cumulative evidential pressure produced when well-specified conversion attempts repeatedly fail under conditions that the current conversion model treats as sufficient or strongly enabling.

Such pressure should revise the model rather than being absorbed indefinitely as unexplained friction. Negative cases are especially valuable when the theory would otherwise be able to classify every outcome as a conditional conversion.

24.11.7 Conversion under Power

Conversion interfaces frequently distribute authority as well as technical functionality. A gatekeeper can determine admissible sources, acceptable evidence, recognition categories, prices, timing, interoperability, appeal procedures, and which alternatives remain available. Power therefore enters value conversion not only after value has been produced, but in the constitution of what can become convertible in the first place.

Definition 24.264 (Conversion-regime power profile). A *conversion-regime power profile* records the positions able to alter admission, classification, validation, terms, timing, burden, target recognition, alternative pathways, appeals, and rule revision within a specified conversion architecture, together with the dependencies and exit options of affected positions.

The profile extends earlier conversion-power analysis by treating the conversion regime itself as historically revisable. Control over a present interface can alter future convertibility by changing categories, standards, infrastructure, or institutional expectations. A platform can modify monetization rules; a professional body can redefine valid credentials; a state can change the conditions under which claims receive legal recognition. The exercise of conversion power can therefore alter the future source–target map rather than merely select outcomes within a fixed map.

Definition 24.265 (Conversion-rule endogeneity). *Conversion-rule endogeneity* exists when actors materially affected by or exercising power within a conversion regime

can alter the rules, categories, technologies, or institutional conditions that define subsequent convertibility.

Power analysis should nevertheless remain discriminating. Differential conversion outcomes do not by themselves establish power. Differences can arise from capacity, timing, complementary resources, legal constraints, or heterogeneous source conditions. A power claim requires evidence that one position can materially affect another position's conversion possibilities or terms in a way that is not reducible to mere difference.

Proposition 24.266 (Power-sensitive conversion condition). *GRE should attribute conversion power when a position can materially alter another position's conversion feasibility, terms, timing, recognition, burden, or alternatives through control or influence over a conversion interface or condition, and when serious non-power explanations of the observed asymmetry have been considered.*

The normative assessment of such power remains separate. Some gatekeeping is necessary for safety, verification, coordination, or rights protection. Whether a particular conversion regime is legitimate, exploitative, unjust, or appropriate requires additional normative and domain-specific warrant.

24.11.8 Conversion without Equivalence

Value conversion does not require source and target to share a common metric, substance, or evaluative standing. This feature gives the concept much of its usefulness, because economically important transformations frequently connect heterogeneous forms. It also creates one of its largest interpretive risks. Once a conversion pathway is observed, analysts can begin to speak as though the source and target are substitutable representations of the same underlying quantity.

Definition 24.267 (Non-equivalent conversion). *A non-equivalent conversion* is a supported source–target transformation in which conversion is practically or institutionally real while source and target remain non-identical in constitutive conditions, evaluative meaning, realization, affected positions, temporal structure, or other dimensions material to the inquiry.

A payment can convert recognized liability into financial settlement without restoring damaged trust. Compensation can convert a legally recognized harm into a monetary remedy without making the harm and payment equivalent value forms. A credential can convert demonstrated learning into institutional eligibility without making learning and credential status interchangeable. Ecological conditions can become legally protected classifications without the legal status exhausting ecological value.

Definition 24.268 (Non-equivalence remainder). *A conversion non-equivalence remainder* records the source-side and target-side dimensions that remain materially non-identical despite successful conversion, including meanings, rights, relations, capacities, temporal properties, affected positions, or normative claims that are not preserved by the transformation.

This remainder connects conversion analysis to the residual-value architecture developed in Section 24.10. Successful conversion can solve a practical problem while leaving uncompensated, untranslated, or non-substitutable dimensions. The rele-

vant discipline is to state what the conversion accomplishes without extending that accomplishment into a stronger equivalence claim.

Proposition 24.269 (Conversion non-equivalence principle). *Evidence that a conversion process reliably connects a source value form to a target value form does not by itself establish commensurability, substitutability, compensation adequacy, reversibility, or normative equivalence between the source and target.*

24.11.9 Empirical Identification

Empirical identification is the deepest open problem of value conversion because the concept concerns a mechanism, not a pattern of covariance. If a source indicator rises before a target indicator rises, several explanations remain possible. The source may have been converted into the target; both may respond to a common cause; the target may have been generated independently; a third value form may have been transferred; the source and target may be two manifestations of one underlying change; classification rules may have changed; or the measured association may be spurious. Temporal order alone does not discriminate among these possibilities.

Definition 24.270 (Conversion-identification dossier). A *conversion-identification dossier* records the proposed source and target value forms, the conversion episode, interface, condition architecture, temporal sequence, affected positions, process evidence, expected intermediate changes, serious rival mechanisms, negative or contrastive cases, and the observations that would weaken or revise the conversion attribution.

The dossier is method-neutral. Process tracing can reconstruct institutional or relational sequences; qualitative evidence can reveal tacit conditions and actor interpretations; experiments or quasi-experiments can estimate consequences of interface or rule changes; longitudinal data can test temporal ordering and persistence; administrative records can identify admission and failure stages; comparative cases can reveal alternative interfaces; and formal models can organize mechanism hypotheses. No single method is automatically privileged. The appropriate evidential combination depends on what the conversion claim asserts.

A useful way to discipline empirical claims is to distinguish levels of identification rather than treating conversion as either observed or unobserved.

Definition 24.271 (Conversion-identification ladder). A *conversion-identification ladder* orders conversion evidence from weak to stronger warrant according to whether research establishes: source–target association; temporal ordering; interface exposure; intermediate process evidence; condition-sensitive outcome differences; discrimination against serious rival mechanisms; and replicated or contrastive evidence across relevant episodes or regimes.

The ladder is not a universal scoring rule. Some mechanisms leave rich process traces but little quantitative variation; others permit strong quasi-experimental comparison while remaining partly opaque internally. Its purpose is to prevent a weak association from being described with the same confidence as a well-traced and contrastively supported conversion mechanism.

Several rival explanations deserve explicit preservation.

Definition 24.272 (Conversion-rival set). A *conversion-rival set* is the set of serious alternative mechanisms capable of producing the observed source–target pattern without the proposed conversion mechanism, including where relevant common-cause change, co-generation, transfer, circulation, reclassification, simultaneous manifestation, measurement substitution, target-side generation, and selection into the interface.

The rival set should be proportional rather than exhaustive. The objective is not to enumerate every logically imaginable explanation, but to retain the alternatives that would materially change the interpretation or intervention if true.

Proposition 24.273 (Conversion-identification condition). *A GRE conversion claim acquires stronger empirical warrant when the source and target are independently typed, a materially relevant interface and condition architecture are reconstructed, predicted intermediate changes are observed where accessible, serious rival mechanisms are weakened by process, comparative, or intervention evidence, and failed or negative cases remain capable of revising the source–target model.*

This condition deliberately avoids requiring one universal causal design. Historical, legal, ecological, organizational, educational, technological, and market conversions differ in observability and manipulability. What should remain constant is the demand that the conversion mechanism do explanatory work beyond redescribing correlated change.

Definition 24.274 (Conversion attribution ceiling). A *conversion attribution ceiling* is the strongest conversion claim warranted by the available provenance, interface reconstruction, condition evidence, rival-mechanism discrimination, and negative evidence in a specified inquiry.

The attribution ceiling provides a practical stopping rule for epistemic humility. Evidence may justify saying that a conversion pathway is plausible, that an interface materially contributes to conversion, that a conversion mechanism is strongly supported in one regime, or that a specified source is reliably convertible under stated conditions. It may not justify a universal source–target law, a scalar conversion rate, or a claim that the same mechanism operates across domains.

Proposition 24.275 (Conversion open-problem principle). *Value conversion should remain an open empirical and theoretical research object whenever the source–target transformation, interface, conditions, loss, gain, reversibility, failure structure, power relations, or rival mechanisms remain materially underdetermined; uncertainty in those dimensions should narrow the conversion claim rather than be absorbed into an unrestricted conversion vocabulary.*

The section therefore leaves value conversion neither as a metaphor nor as a completed formal object. Its usefulness depends on a disciplined distinction among transformation, transfer, circulation, generation, representation, and institutional recognition, together with empirical procedures capable of deciding which mechanism is operative in a particular case. The next section turns to the open problem of value circulation: even where value has been generated or converted, how can its subsequent circulation, dissipation, capture, return, regeneration, and cross-form transmission be traced without presuming scalar conservation or homogeneous flow?

24.12 Open Problems of Value Circulation

Section 24.11 treated value conversion as an identification problem: a source–target association does not establish a conversion mechanism, and even a well-supported conversion does not establish equivalence between the value forms involved. The present section addresses the next open problem in the value-process architecture. Once value-bearing conditions have been generated, transferred, transmitted, converted, or recognized, their later movement through economic and institutional relations can remain difficult to reconstruct. The role of this section is therefore to examine the limits of attributing *circulation*: which paths are materially part of the circulation process, how circulation crosses domains and scales, how delays and repeated re-entry alter the path, where dissipation or capture occurs, when circulation contributes to regeneration, and how transmission can be formalized without presuming a conserved scalar. The method is provenance-preserving and mechanism-oriented. A circulation claim should identify the value-bearing condition, the path through which it becomes consequential, the transformations and losses occurring along that path, the affected positions, and the evidential limits on reconstructing the complete circulation architecture.

The main difficulty is that circulation is neither a synonym for transfer nor a claim that one unchanged object travels around a closed loop. Earlier chapters defined economic circulation as a temporally extended configuration of linked transfers that can include transformation, delay, return, accumulation, dissipation, capture, or regeneration. That broad definition is useful because it includes money, rights, knowledge, capability, recognition, institutional authority, ecological conditions, and other heterogeneous value-bearing forms. Its breadth also creates an open identification problem. A researcher can too easily infer a circulation process from repeated observations of similar value manifestations, from aggregate flows whose internal paths are unknown, or from a return event whose provenance has not been reconstructed. The task in this section is therefore to make circulation analytically demanding enough to remain discriminating.

Table 24.12 summarizes the limitation architecture developed below.

24.12.1 Circulation Path Architecture

A circulation claim concerns a path rather than a pair of endpoints. The endpoints can be important, but they are insufficient when intermediaries transform what passes through them, when several routes coexist, when path selection depends on institutional rules, or when downstream effects reach positions not represented in the initial transfer. A remittance, for example, can move through employers, payment systems, currency conversion, banking rules, household allocation, debt relations, and local markets before its longer-term effects become visible. A research finding can circulate through publication, translation, standards, training, organizational adoption, and policy. The same nominal source and final recipient can therefore be connected by materially different circulation architectures.

Definition 24.276 (Circulation-path reconstruction). A *circulation-path reconstruction* is a bounded account of the materially relevant sequence of positions, intermedi-

Table 24.12: Open problems in value-circulation analysis

Problem	Principal identification risk	Required GRE discipline
Path reconstruction	Aggregate movement is treated as a known relational path	Preserve provenance, intermediaries, path alternatives, transformations, and affected positions
Cross-domain circulation	Passage between domains is treated as semantic continuity	Re-type the value form and retain domain-specific warrants and remainders
Cross-scale circulation	Aggregation is confused with movement between scales	Specify mediation, incidence, aggregation rules, and feedback across levels
Delay	Later effects are attributed directly to an earlier source	State latency, intervening conditions, rival sources, and temporal uncertainty
Recirculation	Any recurrence is interpreted as return to generation	Identify the prior episode, re-entry pathway, and later generative condition
Dissipation	Reduced observability or realization is equated with value destruction	Distinguish attenuation, decay, diversion, transformation, and measurement loss
Capture	Unequal receipt is treated as appropriation	Identify control over routing, retention, redirection, or realization and its counterfactual relevance
Regeneration	Repeated circulation is assumed to reproduce its enabling conditions	Establish the mechanism through which circulation restores or expands later capacity
Non-conservation	Flow language silently imports a conserved scalar	Permit replication, amplification, depletion, transformation, and heterogeneous remainder
Formal transmission	Mathematical paths are treated as self-interpreting	Define nodes, edges, events, types, composition rules, and empirical semantics locally
Heterogeneous transfer	Similar manifestations are treated as the same moving value	Preserve source and target forms, conversion steps, and non-equivalence remainders
Justice	Descriptive path asymmetry is converted directly into a normative verdict	Separate incidence and control evidence from the normative framework used for evaluation

aries, relations, transfer events, transformations, delays, and affected parties through which a specified value-bearing condition becomes consequential beyond its initial location over a stated horizon.

The reconstruction is necessarily purpose-relative. A payment-settlement inquiry may not require the later household use of the funds, while a capability inquiry may need to trace whether the payment actually became housing stability, education, health access, debt reduction, or another condition. Path completeness is therefore not an absolute demand. What matters is whether omitted segments could reverse, substantially weaken, or retype the claim being made.

Definition 24.277 (Circulation-path adequacy). *Circulation-path adequacy* is the degree to which a reconstructed path contains the segments, transformations, intermediaries, and affected positions needed to support the specific circulation claim while making materially relevant omissions explicit.

Circulation paths can branch and merge. One source can produce several downstream consequences, while several sources can converge on one later condition. This makes simple source attribution difficult. A scholarship may contribute to capability, credentials, professional networks, household finances, and later knowledge production. Conversely, later occupational capability can reflect education, prior experience, health, social support, legal status, and organizational learning. GRE should therefore avoid reading a path diagram as a proof that every downstream state is attributable to one upstream source.

Proposition 24.278 (Path non-exclusivity principle). *Evidence for a materially relevant circulation path from one source does not by itself establish that the source is necessary, sufficient, or exclusive for the later value-bearing condition when alternative,*

convergent, or branching paths remain serious possibilities.

The open problem is consequently not to produce maximally large path maps, but to identify the smallest path architecture that preserves the mechanisms material to the claim and the strongest rival paths that could change its interpretation.

24.12.2 Cross-Domain Circulation

Value-bearing conditions can become consequential across disciplinary and institutional domains. Scientific knowledge can become educational content, organizational capability, legal evidence, technical standards, political authority, or commercial advantage. Ecological conditions can become legal restrictions, financial risks, political claims, or community capabilities. Social recognition can become institutional access, reputational advantage, or exclusion. These movements can be economically consequential, but cross-domain circulation should not be represented as if one stable value substance simply crossed a boundary.

Definition 24.279 (Cross-domain circulation episode). A *cross-domain circulation episode* is a circulation segment in which a value-bearing condition becomes effective within a domain whose constitutive categories, evidential warrants, institutional rules, or evaluative semantics differ materially from those governing the preceding segment.

The definition makes cross-domain circulation dependent on retyping. A scientific result does not become legal validity merely by entering a courtroom. A community value does not become market value merely because a price is assigned. An ecological state does not become political legitimacy because it becomes salient in public debate. A domain interface can transmit evidence, recognition, constraint, capability, or a converted representation while leaving significant semantic and normative remainders.

Definition 24.280 (Domain-transition remainder). A *domain-transition remainder* records the materially relevant properties, warrants, meanings, affected positions, or normative claims that are not preserved when a value-bearing condition becomes effective across a domain boundary.

The domain-transition remainder prevents the path from being narrated as semantic continuity. It also connects the present section to the book's preceding cross-domain analysis, where neighboring domains retained independent correction authority. If the legal, ecological, educational, social, political, or aesthetic premise changes, the economic interpretation of the cross-domain circulation may also require revision.

Proposition 24.281 (Cross-domain retyping condition). A *GRE claim about cross-domain circulation should identify the domain transition, the representation or mechanism through which the transition occurs, the value form operative on each side, and any domain-specific remainder material to the economic conclusion; repeated use of one label across domains does not establish continuity of value semantics.*

Cross-domain circulation can therefore be real without being homogeneous. The path is reconstructed through a sequence of domain-specific realizations, translations, and conversions rather than through an assumed universal value carrier.

24.12.3 Cross-Scale Circulation

Scale introduces a different problem. A value-bearing effect can move among individual, household, organizational, community, regional, national, transnational, infrastructural, or ecological configurations. Yet movement between scales is not equivalent to aggregation. Individual learning can contribute to organizational capability, but organizational capability is not simply the sum of individual learning. Local tax bases can support national revenue, which can later finance local infrastructure, but the aggregation, allocation, and return stages are governed by institutions that alter incidence. Local ecological degradation can accumulate into wider system effects, while wider regulation can change local incentives and constraints.

Definition 24.282 (Cross-scale circulation architecture). A *cross-scale circulation architecture* records the mechanisms by which a value-bearing condition, consequence, representation, or constraint becomes consequential across differently constituted analytical scales, including the aggregation, disaggregation, mediation, translation, and feedback processes through which the scale transition occurs.

Cross-scale claims therefore need more than a change in the unit of observation. They should specify whether the relevant mechanism is aggregation, institutional pooling, distributed coordination, network propagation, hierarchical delegation, ecological coupling, shared infrastructure, or another process. Otherwise an apparent movement from micro to macro or macro to micro can be an artifact of measurement rather than a circulation mechanism.

Definition 24.283 (Scale-transition incidence profile). A *scale-transition incidence profile* records which positions contribute to, mediate, receive, benefit from, bear burdens from, or remain excluded by a cross-scale circulation process, together with the rules through which scale-level effects are distributed back to differently situated positions.

The incidence profile is needed because aggregate return can conceal local non-return. A region can contribute labor, data, ecological capacity, or tax revenue to a wider system while receiving little later capability or institutional investment. Conversely, a wider system can subsidize local resilience without a proportional local contribution. Neither pattern is evaluatively settled by the circulation description alone, but both change the distributional and power questions that later analysis must address.

Proposition 24.284 (Cross-scale non-aggregation principle). A *change observed at one analytical scale should not be attributed to cross-scale value circulation solely because related changes appear at another scale; the claim requires a materially relevant mediation, aggregation, disaggregation, or feedback mechanism connecting the scales.*

24.12.4 Temporal Delay in Circulation

Circulation can be delayed at several points. Institutions can hold resources before allocating them. Knowledge can remain unused until complementary technology appears. Education can affect capability years after instruction. Ecological restoration can require long periods before downstream conditions change. A legal recognition can remain formally valid while practical realization waits for administrative imple-

mentation. Delay therefore changes both attribution and evaluation.

Definition 24.285 (Circulation latency). *Circulation latency* is the temporally consequential interval between a specified transmission, transfer, conversion, or propagation event and the later stage at which the relevant value-bearing effect becomes materially realized, redirected, returned, or observable.

Latency is not a residual time lag. It can have mechanisms: maturation, institutional processing, waiting, accumulation, learning, infrastructure construction, ecological regeneration, strategic withholding, or coordination delay. The mechanism matters because it determines whether the delay should be treated as ordinary maturation, avoidable friction, gatekeeping, risk management, or another process.

Definition 24.286 (Delay-attribution window). A *delay-attribution window* is the historically and mechanism-specific interval within which an earlier circulation event remains a serious explanatory contributor to a later value-bearing condition, given intervening events, competing sources, decay, transformation, and uncertainty.

The attribution window guards against two opposite errors. A window that is too short misses long-horizon transmission and generative return. A window that is too long makes nearly any later effect attributable to an earlier event. The appropriate horizon depends on the mechanism and the evidence, not on a universal temporal rule.

Proposition 24.287 (Delayed-circulation attribution condition). *The longer the temporal separation between a proposed circulation source and a later realization, the more the claim should preserve intervening conditions, rival sources, path discontinuities, decay or transformation, and evidence capable of weakening the attribution.*

Delay can also alter incidence. A policy may impose present burdens while producing later benefits for different positions. An ecological intervention can benefit future populations that did not bear its present cost. A delayed circulation analysis should therefore preserve temporal distribution rather than discounting every position into one contemporaneous account without independent justification.

24.12.5 Recirculation and Re-entry

Recirculation concerns re-entry into later generative conditions. It is therefore more demanding than recurrence. A payment can recur monthly without altering or re-entering the conditions that produce later value. By contrast, revenue used to maintain productive infrastructure, knowledge returned to a community as usable capacity, or institutional learning incorporated into later decision procedures can form a genuine recirculatory path.

Definition 24.288 (Recirculation dossier). A *recirculation-identification dossier* records the earlier value-bearing episode, the condition that persists or is transformed, the return or redirection pathway, the later generative configuration into which it re-enters, the affected positions, the temporal separation, and the evidence linking the earlier episode to the later generative role.

The dossier distinguishes recirculation from repetition, repayment, replacement, and ordinary redistribution. A replacement input can maintain production without being derived from an earlier output. A repayment can close a liability with-

out strengthening later generation. A recurring subsidy can support a system while leaving the system dependent on external inflow. Recirculation becomes analytically distinctive when earlier outputs or consequences become inputs, capacities, institutions, relations, knowledge, options, or ecological conditions that materially shape later generation.

Definition 24.289 (Recirculatory transformation). *A recirculatory transformation occurs when re-entry changes the relations, capabilities, rules, infrastructures, technologies, evaluative practices, or option structures through which subsequent circulation or generation takes place.*

Recirculation can therefore be self-modifying. A platform reinvests revenue into infrastructure that changes future ranking and access; a public programme converts lessons into revised eligibility rules; a community return creates a new institution; ecological regeneration alters future production constraints. The later cycle is not simply another iteration of the first.

Proposition 24.290 (Recirculation non-self-sufficiency principle). *Evidence for a recirculatory path does not by itself establish that the relevant system is self-sustaining, regenerative, independent of external support, or normatively desirable; those stronger claims require separate evidence concerning maintenance, external inputs, burdens, capture, and later system transformation.*

24.12.6 Dissipation in Circulation

Circulation can weaken, decay, or cease before a value-bearing condition reaches a later position. Yet the word *dissipation* can become misleading if every reduction between an upstream and downstream manifestation is called loss. Some reductions reflect legitimate use, conversion, allocation, depreciation, transformation into an unmeasured form, or a change in the relevant comparison boundary. The open problem is to identify when the circulation process itself materially reduces the later availability or effectiveness of the value-bearing condition.

Definition 24.291 (Circulation dissipation). *Circulation dissipation is a process-specific reduction in the persistence, availability, usability, realizability, or generative capacity of a specified value-bearing condition along a circulation path that cannot be explained adequately as intended transfer, supported conversion, ordinary realization, or mere representational change within the stated inquiry.*

Dissipation mechanisms can include physical decay, maintenance failure, information degradation, skill attrition, trust erosion, transaction burden, exclusion, failed interoperability, institutional delay, or ecological depletion. Different mechanisms require different evidence. A financial fee is observable retention by an intermediary rather than dissipation in the same sense as deteriorating knowledge quality or decaying infrastructure. The categories should therefore remain typed.

Definition 24.292 (Dissipation-location profile). *A dissipation-location profile identifies the circulation segment at which a value-bearing condition becomes materially less persistent, available, usable, realizable, or generative, together with the proposed mechanism, affected positions, alternative explanations, and evidential uncertainty.*

An important empirical complication is unobserved transformation. What ap-

pears to disappear at one register can reappear in another. Financial resources spent on maintenance no longer appear as cash but can persist as infrastructure function. Time devoted to training leaves the time budget but may become capability. The possibility of conversion does not eliminate dissipation, but it means that dissipation claims need cross-form checks where the missing value could plausibly have been transformed rather than destroyed.

Proposition 24.293 (Dissipation attribution condition). *A GRE claim of circulation dissipation should distinguish reduction in the focal value form from transformation into another form and should identify the path segment and mechanism responsible before interpreting an upstream–downstream difference as value loss.*

24.12.7 Capture along Circulation Paths

Capture concerns redirection or appropriation along a circulation path. Unequal receipt alone is insufficient. A circulation architecture can be intentionally redistributive, can compensate intermediaries for genuine functions, or can produce unequal outcomes without any position exercising material control over routing. A stronger capture diagnosis requires evidence concerning control over the path and the counterfactual consequences of that control.

Definition 24.294 (Circulation capture). *Circulation capture* is a process in which a position materially alters, intercepts, retains, conditions, redirects, or appropriates a value-bearing flow or its realization through control over a circulation path in a manner that changes the incidence or later generative availability of that value relative to a relevant alternative path or rule.

Capture can occur through pricing, fees, gatekeeping, proprietary standards, exclusive access, legal entitlement, administrative discretion, information asymmetry, platform rules, or control over recognition. It can also occur through path architecture: a position may not formally own the transmitted object yet can control the only feasible interface through which it becomes usable.

Definition 24.295 (Capture counterfactual). *A capture counterfactual* specifies the serious alternative routing, retention, realization, or governance condition against which a proposed circulation-capture claim is evaluated.

The counterfactual is necessary because some retention is constitutive of the service or institution. The relevant question is not whether an intermediary receives anything, but whether its control over the circulation architecture materially changes incidence, alternatives, or future generation in the manner claimed.

Proposition 24.296 (Capture non-equivalence principle). *Concentration, intermediary retention, unequal receipt, or unequal downstream benefit does not by itself establish circulation capture; the stronger attribution requires evidence of materially consequential control over routing, retention, terms, recognition, or realization relative to a defensible counterfactual.*

Capture can coexist with useful intermediation. A platform can reduce coordination costs while capturing data-based or financial value. A public institution can redistribute resources while acquiring administrative control. The analytical task is therefore mechanism-specific rather than binary.

24.12.8 Regeneration through Circulation

Regeneration is the positive-looking counterpart to dissipation, but it requires equally careful attribution. A system can circulate resources repeatedly while degrading the ecological, relational, institutional, or human capacities that make later circulation possible. Conversely, circulation can restore infrastructure, knowledge, trust, ecosystems, institutional capability, or other generative conditions. The open problem is to identify whether the circulation process actually contributes to restoring or expanding the conditions of future generation.

Definition 24.297 (Circulatory regeneration). *Circulatory regeneration* is a supported process through which one or more circulation paths restore, reproduce, repair, or expand a value-bearing condition or generative capacity that materially supports later activity within the specified system and horizon.

Regeneration can be direct, as when maintenance spending restores infrastructure, or indirect, as when circulating knowledge improves later organizational learning. It can also be cross-form: financial resources can support ecological restoration; community participation can produce institutional trust; public revenue can sustain education that later contributes to capability. Such cases may contain value conversion as well as circulation. The distinction should be preserved rather than folded into a generic claim of return.

Definition 24.298 (Regeneration dependence profile). A *regeneration dependence profile* records the circulation inputs, external supports, maintenance conditions, complementary relations, vulnerable interfaces, and affected positions on which an attributed regenerative process depends.

This profile prevents regeneration from being inferred solely from repeated continuation. A system can persist because external actors repeatedly absorb its costs. It can regenerate one capacity while depleting another. It can appear resilient only because environmental, care, or public infrastructures remain outside the accounting boundary.

Proposition 24.299 (Regeneration attribution condition). *A GRE claim of circulatory regeneration should identify the condition being restored or expanded, the circulation path contributing to that change, the external and complementary supports required, and any materially significant depletion or burden displaced outside the focal path.*

24.12.9 Non-Conservative Circulation Dynamics

Flow language easily invites a conservation metaphor. For some financial or material accounts, conservation-like identities can be justified within a specified boundary. GRE's broader value architecture cannot assume such a property. Knowledge can be copied without leaving the source. Trust can strengthen, weaken, or become differently distributed through repeated interaction. Rights can be extended to additional subjects without subtracting an identical quantity from previous holders. Ecological and material capacities can regenerate or degrade. Institutional recognition can create new opportunities while also excluding others. A circulation process can therefore replicate, amplify, dissipate, transform, or generate value-bearing conditions rather than merely reallocating a fixed stock.

Definition 24.300 (Non-conservative circulation). *Non-conservative circulation* is a circulation process in which the relevant value-bearing forms or generative conditions are not warranted to obey a fixed scalar conservation relation across the specified path and boundary because replication, generation, transformation, dissipation, capture, or regeneration materially changes the represented condition.

Non-conservation is not a claim that accounting identities are unimportant. It requires careful separation of the quantity being accounted for from the broader value claim. Money can be conserved within a closed accounting identity while capability, risk, control, trust, or ecological condition changes substantially. Likewise, a physical material balance can coexist with changing usability or relational significance.

Definition 24.301 (Conservation-claim warrant). A *conservation-claim warrant* states the exact quantity or relation claimed to be conserved, the analytical boundary, the measurement and composition rules, the processes treated as internal or external, and the empirical or institutional reason conservation is expected to hold within the stated scope.

Proposition 24.302 (No default conservation principle). *GRE should not infer conservation of heterogeneous value from the existence of a traceable circulation path; conservation may be imposed locally only for a specifically defined quantity and boundary for which the relevant warrant is independently established.*

This principle is essential for the later formalization subsection. A graph or flow diagram can depict transmission without committing the represented edge weights to a conserved quantity.

24.12.10 Formal Representations of Value Transmission

Formalization can clarify circulation when it preserves path, type, direction, timing, transformation, and incidence. It can also conceal the very distinctions the analysis needs if a generic weighted network is treated as self-explanatory. A transmission graph can show that two positions are connected while leaving unresolved what the edge means, what passes through it, whether the source retains the transmitted condition, whether the receiving position can use it, and whether intermediate transformation occurs.

Definition 24.303 (Typed transmission representation). A *typed transmission representation* is a formal model in which the represented positions, relations, transmission events, value forms, temporal ordering, and transformation or composition rules are given explicit local semantics sufficient for the circulation claim the model is used to support.

The formal object can be a directed graph, temporal network, higher-order relation, event sequence, multilayer representation, process model, or another structure. No one syntax is privileged. The choice should follow the empirical and conceptual structure of the circulation problem. A multilayer network can be useful when financial, epistemic, legal, and institutional paths interact while remaining differently typed. A temporal event model can be preferable when ordering and delay dominate. A higher-order representation can be necessary when a transmission requires a group configuration rather than pairwise edges.

Definition 24.304 (Composition burden). The *transmission-composition burden* is the requirement to justify what it means to compose successive circulation segments when the transmitted forms, relations, scales, or domains differ, rather than assuming that path concatenation automatically preserves one homogeneous quantity or semantic type.

Composition is particularly difficult under heterogeneous value. If knowledge becomes recognition and recognition later enables financial access, the path can be represented, but the two segments do not share one obvious scalar measure. A formal model can represent typed composition or a sequence of transformations without assigning a universal conversion coefficient.

Proposition 24.305 (Formal transmission restraint). *The inferential strength of a formal circulation model should not exceed the independently justified semantics of its positions, relations, transmission types, temporal structure, composition rules, and empirical mapping; formal path existence alone does not establish effective transmission, conservation, value equivalence, or causal sufficiency.*

Formal representations should also retain missing-path uncertainty. An observed network of transfers can omit informal exchange, care, unrecorded knowledge transmission, externalized ecological effects, or hidden control relations. Section 24.5 therefore applies directly: missing relations can change circulation topology and attribution.

24.12.11 Heterogeneous-Form Transfer

Circulation often passes through several value forms. A public research grant becomes labor time, equipment access, knowledge, publications, training, organizational reputation, technical capability, policy influence, and perhaps later financial value. A household payment can become nutrition, time security, educational access, health capability, or debt reduction. The movement is real, yet it does not follow that one common value substance has been transferred through every stage.

Definition 24.306 (Heterogeneous-form circulation sequence). A *heterogeneous-form circulation sequence* is a circulation path containing two or more materially distinct value forms whose connection depends on one or more typed transfer, transmission, conversion, recognition, or generation mechanisms rather than on presumed identity of the forms.

The definition places the conversion discipline of Section 24.11 inside circulation analysis. Where the path changes value type, the conversion mechanism should be identified to the extent required by the claim. Where the same type is transferred, the transfer mechanism should be specified. Where a downstream form is newly generated rather than converted from the upstream form, the analysis should say so.

Definition 24.307 (Heterogeneous transmission ledger). A *heterogeneous transmission ledger* records, for each materially relevant path segment, the operative value form, transfer or transformation mechanism, affected positions, gain or loss attribution where supported, non-equivalence remainder, and evidential status of the linkage to the next segment.

The ledger is not an accounting device that forces commensuration. Its purpose is

the opposite: to keep heterogeneous forms visible while preserving provenance. It can reveal where a circulation story contains an unsupported conversion, where the same output is counted twice, where a value form is lost from view after institutional reclassification, or where downstream generation has been mistakenly attributed to upstream transfer.

Proposition 24.308 (Heterogeneous-transfer non-identity principle). *Traceability across a heterogeneous circulation sequence establishes neither identity nor quantitative conservation of the value forms connected by that sequence; each materially relevant transition requires its own transfer, conversion, generation, or recognition warrant.*

24.12.12 Justice Conditions of Value Transmission

Circulation has normative consequences because path architecture distributes access, delay, burden, control, recognition, risk, and return. Yet the descriptive finding that one position contributes more, receives less, waits longer, or occupies a weaker path position does not settle a justice claim. Justice requires an independently specified normative framework and a defensible account of the positions and values that framework treats as relevant.

Definition 24.309 (Transmission-justice profile). *A transmission-justice profile records the materially relevant contributors, recipients, intermediaries, affected non-recipients, path controllers, burdens, delays, risks, recognition, exit possibilities, returns, residual value, and future generative consequences that an independently specified normative analysis treats as relevant to evaluating a circulation process.*

The profile can support several different normative questions. A distributive inquiry can ask who receives benefits and bears costs. A recognitional inquiry can ask whose contribution or value form is rendered legible. A participatory inquiry can ask who can alter the circulation rule. A relational inquiry can examine dependency, domination, reciprocity, or standing. An intergenerational inquiry can compare present extraction with later regenerative conditions. GRE can organize the relevant evidence, but the normative criterion should not be inferred from circulation efficiency or generativity alone.

Definition 24.310 (Transmission-rule contestability). *Transmission-rule contestability is the practical capacity of materially affected positions to understand, question, challenge, negotiate, revise, or seek alternatives to the rules governing value transmission, routing, retention, recognition, and return within the relevant institutional setting.*

Contestability is not a universal justice criterion, but its absence can be materially relevant when path control generates persistent dependence or forced commensuration. Similar caution applies to reciprocity. A circulation process can be just without symmetrical exchange, and symmetrical exchange can be unjust when the background positions are severely unequal. The evaluative task is therefore not to demand one circulation pattern but to expose the architecture through which normative claims can be argued and contested.

Proposition 24.311 (Transmission-justice non-derivation). *No finding about circula-*

tion efficiency, path centrality, value retention, recirculation, regeneration, or aggregate return is sufficient by itself to establish the justice of a transmission architecture; a justice conclusion requires an explicit normative warrant together with the incidence, control, recognition, participation, and temporal evidence material to that warrant.

The open problems developed across this section can now be summarized by one broader discipline.

Proposition 24.312 (Value-circulation open-problem principle). *Value circulation should remain an open empirical and theoretical research object whenever the materially relevant path, domain or scale transitions, delays, re-entry structure, dissipation, capture, regeneration, transmission semantics, heterogeneous-form transitions, or justice-relevant incidence remain underdetermined; uncertainty in those dimensions should narrow the circulation claim rather than be absorbed into a generic metaphor of value flow.*

This principle preserves the usefulness of circulation while limiting its rhetorical expansion. A circulation account is strongest when it identifies how value-bearing conditions become consequential through time and relation without pretending that all movement is homogeneous, conserved, complete, or normatively desirable. The next section turns to power-theoretical limits. The value-path architecture developed here makes that transition direct: power can operate not only through possession or conversion, but through control over circulation routes, delay, recognition, retention, interruption, and the rules governing who can redirect or contest value transmission.

24.13 Power-Theoretical Limits

Chapter 16 developed economic power as a relationally constituted, directionally organized, historically situated structure through which one position or organized configuration persistently and efficaciously conditions another economically relevant position's feasible action, access, capacities, relations, value processes, or future trajectories. Sections 24.11 and 24.12 have since made two especially important interfaces more explicit: power can operate through the conditions of value conversion and through control over circulation paths, retention, delay, recognition, and return. The role of the present section is to turn that expanded architecture back onto the concept of power itself. Its objective is not to replace the Chapter 16 account, but to identify the limits that arise when relational, modal, control-based, interface-based, and historical descriptions are treated as if they were interchangeable or scalar manifestations of one homogeneous substance. The method is reconstructive and type-preserving. Each power claim should state the affected relation, the conditioning capacity or mechanism, the practical alternatives, the relevant horizon, the historical supports, and the evidential basis for attributing the effect to a position or organized configuration.

The principal difficulty is conceptual overextension in two opposite directions. If power is defined so broadly that every relation, asymmetry, influence, constraint, central position, or consequential difference counts as power, the concept loses discrimination. If power is defined too narrowly as ownership, command, intentional

Table 24.13: Principal limits in GRE power analysis

Analytical object	Principal overreach risk	Required GRE discipline
Power as relation	Any consequential relation is re-described as power	Identify directional conditioning, affected possibilities, dependence, mechanism, and historical scope
Power as capacity	Mere possession or hypothetical ability is treated as operative power	Specify activation conditions, credibility, reach, alternatives, and the capacity–realization gap
Power as control	Formal authority or variable control is equated with power	Establish practical control over a consequential variable and its conversion into another position's constrained or redirected possibilities
Conversion power	Unequal conversion outcomes are attributed to an interface controller	Identify control over admission, rule, timing, recognition, alternatives, or revision and distinguish impersonal conversion conditions
Circulation power	Centrality, intermediation, or retention is treated as power automatically	Reconstruct routing, interruption, delay, retention, redirection, dependence, and feasible bypasses
Recognition power	Differential status or visibility is treated as sufficient for power	Show how recognition conditions access, standing, value realization, credibility, or later possibilities through an attributable mechanism
Persistent asymmetry	Durable inequality is treated as durable power	Reconstruct persistence of the conditioning mechanism, role continuity, counter-power, and alternative non-power explanations
Unified concept	Heterogeneous mechanisms are collapsed into one scalar or universal genealogy	Retain a minimal relational kernel with typed power profiles, partial comparability, and explicit non-equivalence remainders

coercion, or formal authority, GRE misses infrastructural, epistemic, symbolic, temporal, conversion, circulation, and distributed forms that materially condition feasible trajectories. The limitation problem is therefore one of preserving a sufficiently general power concept while retaining typed mechanisms and falsifiable attribution conditions.

Table 24.13 summarizes the principal limits developed below.

24.13.1 Power as Relation

GRE treats economic power as relationally constituted. This claim is analytically important because a resource stock, technical capability, legal office, reputation, database, infrastructure, or temporal advantage does not become power in isolation. It becomes power-relevant through a relation in which the position can condition another position's feasible action or future possibilities. Relational constitution, however, creates its own limit. If every economically consequential relation is called a power relation, the category ceases to distinguish cooperation, coordination, reciprocity, ecological dependence, technical constraint, ordinary specialization, and power.

Definition 24.313 (Power-relational attribution). A *power-relational attribution* is a claim that a specified relation or relational configuration carries economic power because it supplies an identifiable directional mechanism through which one position or organized configuration materially conditions another position's feasible action, access, capacities, relations, value processes, or future trajectories over a stated historical scope.

The definition preserves the stronger Chapter 16 criterion. Relationality supplies the architecture within which power can exist; it is not itself sufficient evidence of power. A mutually beneficial specialization relation can generate reciprocal depen-

dence without either side possessing stable conditioning capacity over the other. A person can depend on an ecosystem without the ecosystem becoming an economic power-holder in the sense used here. A firm can face a technical constraint that no identifiable actor or organized configuration can selectively alter. These cases remain relationally structured while failing the attribution burden for economic power.

The same caution applies to directional effect. A relation can affect another position without supplying power to the source position. One household's purchase can alter a seller's revenue; one firm's innovation can change competitive conditions; one migration decision can affect a local labor market. The stronger power interpretation requires a practically consequential capacity or organized mechanism that can condition possibilities in a manner not exhausted by ordinary causal participation in a connected economy.

Definition 24.314 (Relational-power specificity burden). The *relational-power specificity burden* is the requirement that a GRE power claim identify the relation, direction of conditioning, affected possibility or capacity, relevant dependence, operative mechanism, practical alternatives, and historical horizon that distinguish the proposed power relation from ordinary relational causation or interdependence.

A relation can also contain reciprocal power. Position *A* can condition *B* through access to finance while *B* conditions *A* through scarce technical expertise. The existence of both directions does not cancel power, nor does it imply a single net rank. The relations can differ in object, horizon, intensity, reversibility, and substitutability. A relational analysis therefore supports typed directional claims more readily than an aggregate statement that one party is simply "more powerful."

Proposition 24.315 (Relational non-totalization of power). *Evidence that one position carries a power relation toward another in a specified domain does not establish a general ranking of the positions across other relations, mechanisms, horizons, or affected possibilities; reciprocal, orthogonal, or incomparable power components can coexist within the same coupled configuration.*

The relational conception of power is therefore strongest when it narrows rather than universalizes the claim. It asks *who or what conditions whom, through which relation, with respect to which possibilities, under which alternatives and horizon*. The answer can be distributed across several actors, institutions, infrastructures, and procedures. Distributed attribution does not weaken the relation account, but it does require the analyst to avoid assigning to one visible actor a capacity carried by a larger configuration.

24.13.2 Power as Capacity

Power is often described modally: a position can withhold a resource, alter a rule, deny access, impose delay, redirect a path, classify a claim, or exit a relation even when the capacity is not currently exercised. Chapter 16 already distinguished power capacity from overt exercise because credible capacities can condition behavior before intervention occurs. The open limit concerns how far this modal reasoning can extend before power becomes indistinguishable from merely conceivable ability.

Definition 24.316 (Power-capacity attribution). A *power-capacity attribution* is a

claim that a position or organized configuration possesses a practically credible ability to activate, maintain, withhold, modify, or redirect a mechanism that would materially condition another position's feasible action or future trajectory under specified activation conditions and within a stated horizon.

Credibility matters. A contractual right that cannot be enforced, a veto that cannot be used without destroying the holder's own essential capacity, a technical permission unavailable in practice, or a nominal exit option whose exercise is prohibitively costly may supply weak evidence of operative power. Conversely, a capacity need not be exercised repeatedly when the affected position reasonably anticipates that it can be exercised and organizes behavior around that expectation.

Definition 24.317 (Capacity–realization gap). The *capacity–realization gap* is the analytically material difference between a represented power capacity and the historically operative conditioning relation produced when activation conditions, credibility, complementarity, institutional uptake, resistance, and practical alternatives are taken into account.

The gap can run in both directions. Formal capacity can overstate practical power when implementation is weak, countervailing institutions are strong, or substitutes are abundant. Observable exercise can also understate capacity when compliance occurs in anticipation of intervention and the holder rarely needs to act overtly. Empirical analysis should therefore combine evidence about rights, resources, technical ability, organizational routines, prior use, credible threats, expectations, dependence, and actual alternatives rather than infer power from any single indicator.

Capacity claims are also horizon-dependent. A dominant supplier can possess substantial short-run power while substitution becomes feasible over several years. A regulator can have immediate authority but limited capacity to sustain enforcement. A worker with scarce expertise can possess bargaining capacity during a project deadline but not after organizational learning diffuses the knowledge. The capacity should therefore be indexed to the period during which the proposed intervention remains practically consequential.

Proposition 24.318 (Modal restraint in power attribution). *A hypothetical ability supports a strong GRE power claim only to the extent that the inquiry can justify its practical credibility, activation conditions, consequential reach, temporal horizon, and relation to the affected position's effective alternatives; remote or institutionally unrealizable possibilities should not be treated as equivalent to operative conditioning capacity.*

Power as capacity is thus neither purely dispositional nor reducible to observed exercise. The limitation discipline is to keep the modal component empirically and historically tethered. This also protects the later analysis of persistent power: a structure can remain powerful through credible capacity even during periods of quiescence, but the inference cannot survive indefinitely without evidence that the relevant activation architecture remains operative.

24.13.3 Power as Control

Control is one important mechanism through which capacity becomes power. Chapter 16 defined control capacity as the practically effective ability to set, maintain, alter,

withhold, authorize, sequence, or condition a variable that contributes materially to another position's feasible action or future trajectories. The limitation is that control and power are not equivalent concepts. A position can control a variable that is economically irrelevant to others, while a position can possess power through dependence, exit, symbolic authority, or infrastructural position without directly controlling another actor's behavior.

Definition 24.319 (Control–power conversion burden). The *control–power conversion burden* is the requirement that a GRE analysis show how practical control over a specified variable is converted into material conditioning of another position's feasible action, access, capacities, relations, value processes, or future trajectories rather than inferring power from control status alone.

Formal authority is a common source of over-attribution. Ownership, office, administrative jurisdiction, voting rights, technical permissions, or contractual clauses can identify a potential control channel. They do not settle whether the holder can use the channel effectively. Implementation capacity, legal review, countervailing authority, technical interdependence, organizational resistance, public accountability, and practical alternatives can all narrow the effect. The inverse error also occurs when informal or distributed actors exercise substantial practical control without holding the formal entitlement most visible in the record.

Control can be partial and distributed. A payment architecture can divide rule-setting, verification, liquidity provision, routing, settlement, dispute resolution, and technical maintenance across different organizations. A platform can control ranking while sellers control inventory and users control participation. A public agency can set eligibility while courts constrain interpretation and local organizations mediate access. The power analysis should therefore identify which consequential variable each position can condition rather than attributing sovereignty to the system's most visible node.

Definition 24.320 (Distributed control profile). A *distributed control profile* records the consequential variables in a power-relevant process, the positions able to condition each variable, the conditions and limits of that control, the dependencies linking the positions, and the review, veto, substitution, or counter-power mechanisms capable of modifying the resulting effect.

Control also differs from influence. Influence can alter expectations, salience, preference, interpretation, or coordination without providing a reliable capacity to set a consequential variable. Influence can still become power when it enters a reproducible mechanism that materially conditions another position's possibilities. The evidential burden should then concern the mechanism and its consequences, not the analyst's intuition that persuasion or prestige “feels powerful.”

Proposition 24.321 (Control non-equivalence principle). *Neither formal control nor practical influence is sufficient by itself to establish economic power; the stronger claim requires an identifiable mechanism connecting a practically effective control or influence capacity to material conditioning of another economically relevant position under the stated alternatives and historical scope.*

The distinction matters because a control-centered theory can become too narrow, while an influence-centered theory can become too broad. GRE can retain both by

treating control as one typed mechanism within a larger relational account of power rather than as the essence of power itself.

24.13.4 Power over Conversion

Section 24.11 showed that value conversion depends on conditions and interfaces rather than on the source value form alone. Power becomes relevant when some positions can materially shape those conversion conditions. Admission rules, eligibility categories, recognition standards, timing, pricing, documentation, interface design, appeals, complementary resources, and revision procedures can each determine whether a nominal resource or value-bearing condition becomes effective capacity or later value.

Definition 24.322 (Conversion power). *Conversion power* is economic power whose principal conditioning mechanism arises from a position's practically consequential capacity to shape the conditions, rules, interfaces, timing, recognition, alternatives, or revision procedures through which another position attempts to convert a specified source value form into a target value form or capability.

This definition is narrower than the existence of unequal conversion rates. Two people can convert the same nominal resource differently because of health, geography, technology, ecological conditions, prior learning, stochastic events, or complementary resources that no relevant actor controls. A power claim requires an attributable relational mechanism. The analyst should therefore separate an adverse conversion environment from a conversion architecture that another position or organized configuration can materially shape.

Definition 24.323 (Conversion-power attribution profile). A *conversion-power attribution profile* records the source and target forms, the conversion interface, the consequential rule or condition under control, the controlling position or configuration, the affected position's dependence and alternatives, the available review or bypass mechanisms, and the evidence linking control of the interface to the observed conversion possibility or failure.

Conversion power can operate without directly denying conversion. A gatekeeper can impose delay, increase documentary burden, reduce target recognition, narrow the set of acceptable source forms, or control which alternatives are visible. The effect can therefore concern probability, cost, timing, durability, or recognized status rather than a binary permission. Power can also operate through the ability to revise the conversion rule, which is a stronger historical position than merely administering a fixed procedure.

Definition 24.324 (Conversion-rule power). *Conversion-rule power* is conversion power exercised through material influence over the creation, interpretation, modification, exception structure, or revision of the rules that determine which source conditions are admissible and how they can become target value or capability.

A position that controls current conversion outcomes but cannot alter the governing rule differs from a position able to redesign the conversion architecture. The latter can reshape future asymmetries and generate path dependence. Yet rule influence still requires evidence of consequential uptake. A proposed rule that is ignored

or routinely circumvented can supply much less power than its formal status suggests.

Proposition 24.325 (Conversion-outcome non-attribution). *Persistent inequality in conversion outcomes does not by itself establish conversion power; GRE should attribute conversion power only where an identifiable position or organized configuration can materially condition the conversion architecture or its effective alternatives and where that conditioning contributes to the differential conversion possibilities under examination.*

This limitation is important for justice analysis. Unequal conversion can be unjust even when no single power-holder caused it, and conversion power can exist even where outcomes happen to be equal in one observed episode. Description of power and normative evaluation should therefore remain distinct.

24.13.5 Power over Circulation

Section 24.12 reconstructed circulation as a path architecture containing routing, mediation, delay, transformation, retention, re-entry, dissipation, and return. Power can enter at any of these points. A position can control entry to a route, select among paths, delay transmission, retain an intermediate value-bearing condition, redirect flows, interrupt transmission, determine return terms, or prevent affected positions from using alternative routes. This is analytically distinct from simply occupying a central network position.

Definition 24.326 (Circulation power). *Circulation power* is economic power whose principal conditioning mechanism arises from a position's practically consequential capacity to route, delay, retain, interrupt, redirect, transform, prioritize, or condition access to a value-circulation path on which other positions materially depend within the stated domain and horizon.

Centrality can correlate with such power without establishing it. A highly connected node can be easily bypassed, governed by strict nondiscretionary rules, technically interchangeable, or unable to retain what passes through it. A less central node can possess substantial power if it controls a unique bottleneck or a legally indispensable validation step. The relevant object is therefore not structural centrality by itself but the conversion of position into consequential path control.

Definition 24.327 (Circulation-power profile). *A circulation-power profile* records the relevant path segment, the position's routing or interruption capacities, the value-bearing forms affected, the degree of path dependence, available bypasses, temporal exposure, retention or redirection possibilities, downstream incidence, and the institutional or technical constraints on exercising the capacity.

Circulation power can be distributed. One intermediary can control authentication, another settlement, another routing, another recognition, and another appeals. The combined architecture may condition participants more strongly than any single actor can. Attribution should then remain configurational rather than assigning the complete power relation to whichever intermediary is most visible.

Capture and circulation power also need separation. Section 24.12 defined circulation capture by control over routing, retention, recognition, terms, or realization

relative to a defensible counterfactual. Circulation power can exist without capture when a position can redirect or interrupt value but does not appropriate the relevant value. Capture can also depend on several forms of power together, including institutional, infrastructural, epistemic, or symbolic power.

Proposition 24.328 (Path-position non-equivalence). *A position's location, centrality, or intermediation within a circulation path does not establish circulation power unless that position possesses a practically consequential and sufficiently attributable capacity to condition routing, timing, retention, transformation, interruption, recognition, or feasible bypasses for other materially dependent positions.*

The same discipline applies to apparently decentralized architectures. Technical distribution can reduce some forms of unilateral control while leaving governance, standards, identity, liquidity, infrastructure, or recognized interfaces concentrated elsewhere. The power analysis should follow the effective control architecture rather than infer decentralization or centralization from one layer alone.

24.13.6 Power over Recognition

Recognition is economically consequential when classifications, credentials, reputations, identities, statuses, legal categories, expert judgments, rankings, or institutional acknowledgments condition access, standing, credibility, participation, or value realization. Chapter 16 treated symbolic and epistemic power as distinct but interacting forms. The present subsection isolates a recurring limit: recognition differences are often visible, yet the mechanism through which recognition becomes power can remain under-specified.

Definition 24.329 (Recognition power). *Recognition power* is economic power whose principal conditioning mechanism arises from a position's practically consequential capacity to confer, withhold, classify, validate, rank, render visible, or institutionally stabilize a recognized status that materially alters another position's access, standing, credibility, value realization, participation, or future possibilities.

Recognition power is not identical to social esteem. A person can be admired without controlling another's possibilities. A credentialing body can possess recognition power because its classification changes eligibility or standing even when its members do not personally esteem the applicant. A platform ranking can acquire recognition power when visibility materially conditions demand. A public authority can confer legally consequential status, while a professional community can stabilize an epistemic category that shapes later institutional treatment.

Definition 24.330 (Recognition-consequence bridge). *A recognition-consequence bridge* is the evidenced mechanism through which a recognized classification, status, credential, rank, visibility state, or validation decision changes materially relevant access, standing, participation, value realization, or future possibilities for the affected position.

Without such a bridge, recognition analysis can slide from descriptive difference into power attribution too quickly. The same status can matter greatly in one institutional environment and little in another. Recognition can also be plural: one institution may reject a credential while another accepts it; a community can recognize

a contribution that a market ignores; legal recognition can coexist with weak practical uptake. The power claim should therefore specify which recognition order is consequential and why.

Recognition power can also become reflexive. A classification changes access; changed access produces new records; those records reinforce the classification; later institutions treat the accumulated record as independent evidence. Chapter 24's earlier analysis of performative representation is directly relevant. The recursive effect can strengthen power while simultaneously making its origin harder to reconstruct.

Proposition 24.331 (Recognition–legitimacy separation). *The practical efficacy of a recognized status does not establish the epistemic validity, legal correctness, social desirability, or normative legitimacy of the recognition rule that produced it; recognition power and the justification of recognition remain distinct analytical questions.*

This separation is especially important where rankings, credentials, eligibility categories, and automated classifications become highly consequential. GRE can analyze how recognition conditions economic possibilities while deferring the substantive validity of the underlying category to the relevant epistemic, legal, political, educational, or normative domain.

24.13.7 Power under Persistent Asymmetry

Persistent asymmetry is one of the strongest empirical signals that power may be reproduced, but it remains an insufficient criterion. Durable differences in wealth, capability, geography, organizational role, technical specialization, legal status, ecological exposure, or network position can persist for reasons that do not satisfy the GRE definition of power. Conversely, a power structure can persist while the visible asymmetry, institutional carrier, or local mechanism changes.

Definition 24.332 (Persistent-asymmetry audit). *A persistent-asymmetry audit is a historical reconstruction that tests whether a durable directional difference is sustained through an identifiable power mechanism, through non-power structural conditions, through several interacting mechanisms, or through changing role-equivalent arrangements whose continuity must be independently justified.*

The audit should distinguish persistence of the difference from persistence of the power relation. An inherited resource disparity can remain large while the former gatekeeping mechanism dissolves. A formal hierarchy can remain stable while practical control shifts elsewhere. A platform's market share can fall while infrastructural or data dependence preserves another form of conditioning capacity. The historical continuity claim should identify what remains invariant enough to support talk of persisting power.

Chapter 16 introduced adaptive persistence to capture cases in which manifestations, mediators, institutional carriers, or supporting mechanisms change while a directional dynamical role remains historically connected. This concept is useful, but it carries a retrospective danger. If the role-equivalence criterion is defined after observing every successor arrangement, almost any later asymmetry can be narrated as continuation of the earlier power structure.

Definition 24.333 (Power-continuity warrant). A *power-continuity warrant* is the explicit criterion and evidence supporting the claim that historically successive power configurations preserve a materially relevant directional conditioning role despite changes in carrier, manifestation, institutional form, or local mechanism.

The warrant should state both preservation and discontinuity. It should identify which affected positions, possibilities, access relations, interfaces, or dependence structures remain sufficiently connected, and which dimensions changed enough to limit the continuity claim. Power history becomes more credible when it permits genuine dissolution and reformation rather than presuming that power merely changes costume.

Persistent asymmetry can also be maintained by feedback between power and the conditions supporting power. Conversion power can shape capabilities that later reinforce interface control; circulation power can concentrate resources used to govern the circulation architecture; recognition power can create records that stabilize future recognition. Yet feedback should be reconstructed rather than inferred from persistence alone.

Proposition 24.334 (Persistent-asymmetry non-equivalence). *The durability of an asymmetry does not by itself establish persistence, reproduction, or identity of a power relation; those stronger claims require evidence that an identifiable conditioning mechanism or warranted role-equivalent successor continues to shape the affected positions' possibilities across the declared historical scope.*

This discipline also creates room for counter-power. Persistent asymmetry can co-exist with institutions, collective organization, legal protections, public alternatives, technical substitution, or reciprocal dependence that materially limit its conversion into power. GRE should therefore reconstruct the realized power architecture rather than infer it directly from the magnitude or duration of inequality.

24.13.8 Limits of a Unified Power Concept

GRE requires a concept of power general enough to connect resource, capability, epistemic, relational, institutional, infrastructural, symbolic, temporal, exit, conversion, circulation, and recognition mechanisms. At the same time, the book has repeatedly rejected the idea that these forms are scalar manifestations of one measurable substance. The final limitation is therefore architectural: how much conceptual unity can GRE preserve without erasing the mechanisms that make different power relations intelligible?

Definition 24.335 (Minimal GRE power kernel). The *minimal GRE power kernel* is the family resemblance retained across GRE power claims: a historically situated and relationally organized capacity or structure must, through an identifiable directional mechanism, materially condition another economically relevant position's feasible action, access, capacities, relations, value processes, or future possibilities within a declared scope.

The kernel is deliberately weaker than a universal metaphysics of power. It does not require every power relation to originate in the same antecedent asymmetry, operate through direct control, involve conscious intention, produce injustice, repro-

duce itself, or admit a common metric. It instead specifies the minimum structure that makes the term useful within GRE's economic domain.

Definition 24.336 (Typed power profile). A *typed power profile* records, for each power claim, the principal carrier, conditioning mechanism, affected position, affected possibility or value process, dependence relation, alternatives, historical horizon, persistence, causal or generative efficacy, manifestation, counter-power, and uncertainty relevant to that claim.

Typed profiles permit comparison without presuming equivalence. Two power relations can be comparable with respect to one feature, such as reversibility or control over exit, while remaining incomparable with respect to another. A regulator's legal authority, a platform's infrastructural gatekeeping, and a creditor's liquidity control can all condition feasible action while doing so through different institutions, evidence, time horizons, and modes of contestability.

Definition 24.337 (Power incomparability remainder). A *power incomparability remainder* is the set of materially relevant dimensions of two or more power profiles that are not preserved by a proposed common comparison or scalarization and whose omission could alter the interpretation of dependence, reach, reversibility, contestability, historical persistence, or downstream consequence.

This remainder does not prohibit aggregation for a bounded purpose. A governance study can construct an index of selected decision rights, a network analysis can compare brokerage, and an empirical study can estimate effects of particular institutional powers. The limitation arises when the local index is interpreted as total power or transferred across heterogeneous mechanisms without preserving the omitted dimensions.

Proposition 24.338 (Power-composition without scalarization). *Multiple forms of economic power can jointly support, counteract, convert into, or condition one another without being reducible to a single additive power quantity; GRE should preserve the typed mechanisms and their interaction unless a specific scalar representation has an independently justified domain, semantics, and aggregation rule.*

The unified concept also remains genealogy-limited. Chapter 16 explicitly developed an asymmetry-derived construction of economic power and left other genealogies open. The present section does not close that opening. Future research may identify power relations better reconstructed through constitutive authority, subject formation, institutional emergence, collective coordination, or other mechanisms not captured adequately by the current sequence from asymmetry through power relevance to relational realization.

Definition 24.339 (Power-theory revision trigger). A *power-theory revision trigger* is recurrent evidence that economically consequential conditioning cannot be adequately represented by the current GRE power kernel or its typed mechanisms without semantic expansion, ad hoc exceptions, persistent misclassification, or loss of distinctions material to explanation, comparison, or intervention.

Revision can take several forms. GRE can add a new typed mechanism, narrow an existing form, split one category, merge categories shown to be redundant, revise the minimal kernel, or concede that a phenomenon belongs principally to another domain's power theory. The aim is not conceptual stability at any cost, but disciplined

continuity under correction.

Proposition 24.340 (Power-theoretical limitation principle). *GRE should treat power as a typed and historically revisable relational architecture rather than as a universal scalar substance: relation, capacity, control, conversion, circulation, recognition, and persistent asymmetry can each contribute to power analysis, but none is individually sufficient or universally necessary, and claims of unity should preserve the mechanisms, non-equivalences, and revision conditions material to the inquiry.*

This limitation principle preserves the explanatory reach of GRE's power framework while making its boundaries visible. Power remains central because it can shape conversion, circulation, recognition, institutional rules, and future generative conditions. The concept remains scientifically useful only if those pathways can be reconstructed and, where evidence fails, withheld or revised. The next section applies the same discipline to justice. Power analysis can organize evidence about dependence, control, recognition, circulation, vulnerability, and future possibility, but no description of power by itself settles how the resulting relations ought to be evaluated.

24.14 Justice-Theoretical Limits

Chapter 16 developed distributional, relational, generative, relation-variation, and historical dimensions of justice, while Chapter 22 converted those dimensions into a research programme that separates descriptive reconstruction from normative premises. Sections 24.9–24.13 have since sharpened several objects on which justice analysis depends: heterogeneous value, partial and forced commensuration, value conversion, value circulation, and typed economic power. The role of the present section is to turn those refinements back onto justice theory itself. Its objective is to identify where a GRE justice claim becomes underdetermined, overextended, or falsely unified when distribution, recognition, participation, relation quality, generativity, conversion, temporal inheritance, heterogeneous value, or transfer is treated as a sufficient indicator of justice. The method is normatively explicit and type-preserving. Descriptive incidence, causal or generative mechanism, power relation, feasible alternative, affected position, temporal horizon, and evaluative premise should be distinguished even when they interact within one judgment.

The governing limitation is that GRE can reconstruct justice-relevant economic structure more richly than it can determine a uniquely correct normative ordering from that structure alone. This is not a defect specific to GRE. It is a reason to preserve the distinction between identifying what happened, who was affected, through which mechanisms, with which alternatives, and evaluating what ought to have happened or which claims should receive priority. A distribution can be equal and still procedurally or relationally objectionable. A relation can be participatory while reproducing severe material burdens. An arrangement can generate substantial future capability while violating rights or imposing ecological costs. A transfer can improve one recipient's resources while worsening dependence or leaving historical harm unaddressed. A justice framework that treats one of these dimensions as self-interpreting risks turning an analytically useful lens into a master criterion.

Table 24.14: Principal limits in GRE justice analysis

Justice object	Characteristic overreach	Required GRE discipline
Distribution	A measured distribution is treated as normatively self-interpreting	State object, unit, baseline, horizon, conversion conditions, affected positions, and evaluative rule
Recognition	Institutional recognition or visibility is equated with just recognition	Separate recognition incidence, standing, authority, accuracy, burden, and normative warrant
Participation	Inclusion is treated as sufficient for justice	Examine influence, information, burden, accessibility, representation, contestability, and consequences
Relational justice	Several relational dimensions are collapsed into one relation-quality score	Preserve recognition, reciprocity, dependence, domination, continuity, consent, voice, and exit as partially independent
Generative justice	More generation or more options are treated as better or more just	Identify what is generated, for whom, at whose cost, with which foreclosures, and under which normative premise
Conversion justice	Unequal conversion outcomes are treated as evidence of injustice by themselves	Reconstruct interface terms, power, loss, alternatives, voluntariness, residual value, and evaluative standard
Intergenerational justice	Present actors claim determinate knowledge of future interests	Preserve uncertainty, representation limits, transmission mechanisms, reversibility, and future revision capacity
Incommensurable values	Absence of one metric is treated as impossibility of judgment, or one procedure is treated as neutral	Use bounded comparison, thresholds, rights, deliberation, or explicit priority rules while recording residual disagreement
Normative underdetermination	Rich description is presented as yielding one uniquely correct normative conclusion	Record serious competing principles, their implications, and the premises on which conclusions diverge
Transfer justice	Nominal transfer is treated as equivalent to just incidence or complete repair	Trace formal, economic, relational, generative, historical, and third-party incidence together with conditions and alternatives

Definition 24.341 (Justice-theoretical limitation profile). A *justice-theoretical limitation profile* records the justice-relevant economic objects, affected positions, descriptive and causal claims, power relations, feasible alternatives, temporal scope, normative premises, comparison rules, unresolved value conflicts, representational limits, uncertainty, and revision conditions that bound a GRE justice judgment.

The profile extends the justice-research and normative-premise disciplines of Chapter 22. It is especially useful in Chapter 24 because it records not only what supports a justice claim but also what the claim does not establish. A study can strongly identify unequal conversion conditions while remaining normatively open between equality, priority, sufficiency, rights, reciprocity, or another principle. Another study can share the same normative principle while remaining empirically uncertain about who actually bears the burden. Locating the limitation prevents these disagreements from being collapsed into one undifferentiated dispute about “justice.”

Table 24.14 summarizes the principal limits developed below.

24.14.1 Distribution

Chapter 16 showed that distribution in GRE can concern resources, capabilities, usable access, relational opportunities, participation, burdens, and future possibilities rather than one scalar stock. This multidimensionality improves descriptive analysis but also enlarges the normative burden. A finding that one distribution is more equal, more concentrated, or more dispersed than another does not establish whether the pattern is just because justice depends on what is distributed, among which positions,

relative to which baseline and horizon, under which conversion conditions, and according to which evaluative principle.

Definition 24.342 (Distributional-justice bridge). A *distributional-justice bridge* is the explicit normative and empirical linkage connecting a reconstructed distribution to a justice judgment by specifying the distributed object, comparison unit, affected positions, relevant baseline, temporal horizon, conversion conditions, feasible alternatives, and evaluative principle under which the pattern is judged.

The bridge is necessary because the same numerical distribution can carry different normative meanings under different institutions. Equal cash transfers can produce highly unequal effective capabilities where accessibility costs, care burdens, legal status, geography, infrastructure, or conversion interfaces differ. Unequal transfers can sometimes reduce a pre-existing capability disadvantage. Equal shares can be objectionable when prior extraction, need, responsibility, contribution, historical harm, or rights are normatively relevant. Conversely, invoking contextual difference can also become an excuse for entrenched inequality unless the proposed differentiation is independently justified.

Distributional analysis is therefore vulnerable to at least three compression errors. The first compresses heterogeneous objects into one metric. The second compresses persons or positions into equivalent conversion units. The third compresses temporal incidence into a present snapshot. GRE's multidimensional architecture helps reveal these errors, but it cannot decide by description alone which dimension should receive normative priority.

Proposition 24.343 (Distributional pattern non-sufficiency). *No observed degree of equality, inequality, concentration, dispersion, sufficiency, or aggregate improvement is by itself sufficient to establish the justice of an economic arrangement without an explicit account of the relevant object, affected positions, conversion conditions, baseline, alternatives, and normative principle.*

The proposition does not weaken distributive evidence. It states the level at which the evidence is probative. A distributional pattern can establish who receives what and how that pattern changes. A conversion analysis can establish why nominally similar holdings produce different effective capabilities. A power analysis can identify who controls the rules of access. Justice enters when those findings are evaluated through principles whose authority is not supplied by the descriptive pattern alone.

24.14.2 Recognition

Recognition entered the earlier justice architecture as a relation of standing, visibility, acknowledgment, and institutional treatment. Section 24.13 also showed that recognition can become a power mechanism when classifications, credentials, rankings, statuses, or validation decisions materially condition access and future possibilities. These findings create a justice-theoretical limit because recognition has both descriptive and normative meanings. A person can be recognized administratively without being recognized justly; a category can increase visibility while imposing stigma or surveillance; refusal to recognize a harmful or fraudulent claim can sometimes be warranted.

Definition 24.344 (Recognition-justice profile). A *recognition-justice profile* records the recognized position or claim, recognizing authority, recognition rule, practical consequences, evidential or institutional basis, burdens created by classification, opportunities for correction or contestation, excluded or residual identities, and the normative premise used to judge the recognition relation.

Recognition justice therefore cannot be reduced to maximizing recognition. Institutional recognition can enable access to rights, resources, credibility, participation, or remedies. It can also stabilize categories that misdescribe subjects, force heterogeneous positions into administratively convenient identities, or make populations more governable without increasing their practical agency. The relevant question is not only whether recognition occurred but what kind of standing the recognition created, which authority produced it, how revisable it is, and how its consequences are distributed.

The inverse case also matters. Non-recognition can be unjust when it erases contributions, harms, identities, claims, or affected positions. Yet non-recognition can also reflect uncertainty, jurisdictional limits, or refusal to validate an unsupported assertion. GRE therefore requires a bridge between recognition incidence and normative evaluation rather than assuming that visibility and justice move monotonically together.

Proposition 24.345 (Recognition-incidence non-equivalence). *The presence, absence, intensity, or institutional durability of recognition does not by itself establish recognition justice; a justice claim additionally requires evaluation of standing, authority, representation, consequences, burdens, contestability, and the substantive warrant for the recognition rule.*

This limitation is important in AI-mediated and data-intensive institutions, where recognition is increasingly produced through scoring, classification, ranking, and machine-mediated validation. GRE can analyze the economic consequences of these recognition systems. Whether their categories are epistemically valid, legally authorized, politically legitimate, or morally just can require warrants from neighboring domains and explicit normative premises.

24.14.3 Participation

Participation is central to both relational and generative justice because economic subjects can be affected by rules, infrastructures, allocations, and generative processes in which they have unequal opportunity to speak, contest, revise, or contribute. Participation is nevertheless vulnerable to a procedural overreach: the existence of a participatory procedure can be treated as sufficient evidence that the resulting arrangement is just.

Definition 24.346 (Participation-justice profile). A *participation-justice profile* records eligibility, accessibility, information, timing, effective influence, representation, participation burden, power asymmetry, agenda control, contestability, exit, feedback, decision consequences, and the normative significance assigned to participation in the inquiry.

The distinction between access and influence is especially important. A consul-

tation can be formally open while agenda setting, technical language, timing, documentation requirements, or institutional hierarchy sharply constrain which contributions alter the decision. Conversely, a procedure can legitimately assign differentiated authority when expertise, fiduciary responsibility, legal competence, or delegated roles are relevant. Justice does not therefore require that every participant exercise identical influence over every question.

Participation also has costs. Time, emotional labor, translation, travel, disclosure, caregiving, technical preparation, and repeated consultation can impose substantial burdens on the very positions whose inclusion is sought. Participation can become compulsory proof of deservingness or a substitute for institutional responsibility. A justice analysis should therefore ask not only whether voice exists, but whether participation is usable, consequential, proportionate, supported, and non-exploitative.

Proposition 24.347 (Participation non-sufficiency). *Meaningful participation can strengthen the justice of an economic process, but participation alone does not establish the justice of the resulting distribution, relation, rule, or outcome where material burden, domination, exclusion, rights, historical claims, or substantive value conflicts remain unresolved.*

The proposition preserves participation as a constitutive or instrumental value where the applied theory warrants it while rejecting a procedural shortcut. A highly participatory institution can still produce severe injustice. A constrained procedure can sometimes be justified under emergency, expertise, or rights-protecting conditions, though such constraints themselves require justification and review.

24.14.4 Relational Justice

Chapter 16 defined economic relational justice through recognition, participation, reciprocity, non-domination, continuity, exit, and the terms of value transmission. Its strength is that it makes visible injustices that a distributional snapshot can miss. Its limit is that these relational dimensions do not automatically align. A relation can be reciprocal yet dominating, continuous yet exclusionary, participatory yet materially exploitative, protective yet paternalistic, or unequal yet normatively justified by care, responsibility, expertise, or temporary role differentiation.

Definition 24.348 (Relational-justice decomposition). *A relational-justice decomposition is a typed assessment of the distinct justice-relevant properties of an economic relation, including recognition, participation, reciprocity, dependence, domination, authority, consent, continuity, voice, exit, burden, vulnerability, and revision, without presuming that these properties admit one complete scalar ordering.*

The decomposition prevents the phrase “just relation” from concealing internal conflict. For example, continuity can protect trust, care, employment security, or long-term investment, but continuity can also entrench dependence. Exit can protect against domination, but a policy that maximizes exit can weaken commitments necessary for care, public provision, or collective projects. Reciprocity can support mutual standing while being inappropriate as the sole standard for children, persons with unequal capacities, future persons, or relations organized around care and need.

Relational justice therefore needs a conflict discipline rather than a universal rela-

tional score. The applied normative framework must state which properties receive priority and why. GRE contributes by reconstructing the relation and the mechanisms through which its terms become consequential; it does not acquire authority to rank all relational goods merely because they are represented within one framework.

Definition 24.349 (Relational-justice conflict). A *relational-justice conflict* occurs when improving one justice-relevant property of a relation materially worsens another property that remains normatively relevant under the applied framework, so that no purely descriptive relation-quality improvement determines the preferred resolution.

Proposition 24.350 (Relational pluralism constraint). A *GRE relational-justice claim* should not infer overall justice from improvement in one relational dimension when other independently relevant dimensions deteriorate materially; the conflict should remain explicit unless an applied normative principle justifies the priority or tradeoff.

This constraint also limits the reach of power analysis. Domination and dependence are important justice objects, but the presence of power does not prove injustice and the absence of identifiable power does not prove justice. Rights violations, neglect, structural exclusion, or severe deprivation can remain unjust without a strong dyadic power attribution. Justice therefore requires a wider normative architecture than power theory alone.

24.14.5 Generative Justice

Generative justice evaluates how economic arrangements shape capacities, opportunities, option spaces, participation in generation, protection against generative foreclosure, and later possibility. The concept is distinctive to GRE's substantive architecture, but it carries a recurrent danger: generativity can be mistaken for an intrinsic master value. Section 24.9 already established that generative value requires a separate evaluative warrant. The same discipline applies more strongly to justice.

Definition 24.351 (Generative-justice bridge). A *generative-justice bridge* connects a reconstructed change in capacities, opportunities, option spaces, relations, or future possibilities to a justice judgment by specifying affected positions, what is generated or foreclosed, temporal horizon, distribution, burdens, power relations, reversibility, competing values, and the normative principle under which the generative effect is evaluated.

Option expansion provides a clear example. An arrangement can increase the number of technically available actions while increasing surveillance, instability, ecological burden, or dependence. Some options are harmful or trivial; some valuable activities require commitment that deliberately narrows later flexibility. A justice theory cannot therefore maximize option cardinality without specifying option quality, accessibility, distribution, and the values that make particular possibilities worth protecting.

Generative capacity is similarly ambiguous. An institution can become highly capable of producing innovation while concentrating ownership, externalizing ecological cost, or narrowing public control. A society can preserve future productive capacity by imposing present burdens that fall disproportionately on vulnerable positions. A

policy can protect one generation's ability to revise institutions while reducing certainty needed for long-term care or infrastructure. These tensions do not defeat generative justice. They identify its normative dependence.

Proposition 24.352 (Generativity–justice separation). *Evidence that an arrangement generates or preserves capacities, opportunities, options, institutions, knowledge, or future possibilities does not by itself establish justice; a justice claim must additionally evaluate the identity, distribution, accessibility, burdens, foreclosures, and normative standing of what is generated or preserved.*

A further limit concerns attribution. Generative effects are frequently long-horizon and jointly produced. Justice analysis should not assign credit, responsibility, or entitlement to one visible generator when the outcome depends on public infrastructure, prior knowledge, ecological support, care, inherited institutions, or distributed maintenance. Generative justice therefore requires both normative and causal humility.

24.14.6 Conversion Justice

Section 24.11 treated value conversion as a mechanism-identification problem involving source and target forms, conversion conditions, interfaces, loss, gain, irreversibility, failure, power, and non-equivalence. Conversion justice asks a different question: whether the terms under which subjects can convert resources, status, knowledge, rights, recognition, time, or other value-bearing conditions into practically usable forms are just.

Definition 24.353 (Conversion-justice bridge). *A conversion-justice bridge links a reconstructed conversion architecture to a justice judgment by recording eligibility, interface control, source and target forms, conversion conditions, losses, timing, burden, alternatives, residual value, reversibility, appeal, power, affected third parties, and the normative principle used to evaluate those terms.*

Unequal conversion outcomes can be justice-relevant without being sufficient evidence of injustice. Outcomes can differ because needs, preferences, effort, context, technical conditions, or prior positions differ. Conversely, identical conversion rates can conceal injustice when the initial source holdings, burdens, access conditions, or background constraints differ sharply. The justice object is therefore the architecture of conversion rather than equality of one observed ratio alone.

Voluntariness also requires care. A formally chosen conversion can occur under severe dependence, absence of alternatives, misleading representation, or urgent need. Yet background constraint does not make every chosen conversion coercive or unjust. GRE should reconstruct effective alternatives, timing, information, power, and consequences rather than infer voluntariness or coercion from contractual form alone.

Proposition 24.354 (Conversion-outcome justice non-equivalence). *Neither equality nor inequality of observed conversion outcomes is sufficient to establish conversion justice; the judgment depends on the terms of access, control, burden, loss, alternatives, voluntariness, residual value, reversibility, and the normative principles governing the interface.*

Compensation creates a further limit. A successful conversion of money into a rec-

ognized compensation claim does not establish restoration of lost relational, ecological, historical, or future value. Section 24.10 preserved residual value under partial commensuration; conversion justice should therefore record the *non-equivalence remainder* rather than treating payment, replacement, or formal settlement as proof that justice has been fully achieved.

24.14.7 Intergenerational Justice

Intergenerational justice extends the justice horizon beyond currently participating positions. Chapter 16 described intergenerational generative inheritance as the capacities, constraints, ecological conditions, infrastructures, knowledge, institutions, obligations, relational structures, and revision possibilities transmitted across cohorts or generations. The justice limit is epistemic and representational as well as normative: future persons cannot generally state their preferences in current procedures, their identities and circumstances are only partly knowable, and current institutions can confuse preservation of present priorities with protection of future agency.

Definition 24.355 (Intergenerational representation profile). An *intergenerational-justice representation profile* records the future positions whose interests or standing are represented, the proxy or institutional mechanism used, the information available, temporal horizon, uncertainty, transmitted capacities and burdens, ecological and infrastructural conditions, reversibility, revision capacity, intragenerational distribution, and the normative principle authorizing present representation of future claims.

The representation problem creates two opposite risks. One is presentism: current actors discount or omit future burdens because future positions lack direct voice. The other is paternalistic projection: current actors define future welfare so strongly that they narrow later generations' capacity to revise inherited institutions and values. Generative justice suggests protecting revision capacity, knowledge, ecological resilience, institutional competence, and feasible alternatives where appropriate, but it cannot specify every substantive future good.

Temporal aggregation also conceals distribution. A policy that benefits "future generations" in aggregate can burden particular future regions, classes, occupations, or communities. Long-lived infrastructure can support future capability while locking in technical standards or debt. Ecological protection can preserve one capacity while constraining another. Intergenerational justice therefore requires both cross-generational and within-generation incidence.

Proposition 24.356 (Future-standing humility condition). A *GRE intergenerational-justice claim* should protect justice-relevant future standing without presenting uncertain future preferences, identities, or institutional forms as if they were directly observed; where substantive future interests are uncertain, the analysis should state the proxy, preservation rule, reversibility, and revision capacity on which the present judgment depends.

This condition does not imply indifference to foreseeable future harm. Long-lived pollution, debt, infrastructure lock-in, knowledge loss, or institutional destruction can be sufficiently well evidenced to support strong present obligations under an

appropriate normative framework. The limit concerns unwarranted specificity, not responsibility.

24.14.8 Justice under Incommensurable Values

Section 24.10 rejected the assumption that heterogeneous values must either admit one common measure or become wholly incomparable. Justice analysis inherits this middle position. Distributional resources, recognition, autonomy, care, ecological conditions, future possibility, rights, historical repair, and relational standing can be jointly relevant while resisting reduction to one scalar metric.

Definition 24.357 (Non-scalar justice comparison). A *non-scalar justice comparison* evaluates an economic arrangement through several normatively relevant value dimensions using explicitly stated thresholds, constraints, priority relations, rights, qualitative judgments, deliberative procedures, or partial orderings without asserting a complete common metric among those dimensions.

Non-scalar comparison makes action possible without inventing false commensurability. A decision can reject an option because it violates a rights constraint even if the value of that right is not converted into money. A policy can be required to meet ecological and sufficiency thresholds before efficiency comparisons are considered. A deliberative body can judge that one residual loss is unacceptable without expressing the loss as a common unit with every benefit. These practices establish decision rules, not value identities.

The difficulty is that procedures themselves are normative objects. A lexicographic priority, veto, threshold, majority rule, expert judgment, negotiated compromise, constitutional right, or multicriteria procedure is not neutral merely because it avoids scalar aggregation. Each determines which claims can override others, who has standing, and how unresolved remainder is treated.

Definition 24.358 (Justice-relevant residual disagreement). A *justice-relevant residual disagreement* is a material normative disagreement that remains after the descriptive facts, comparison procedure, and feasible alternatives have been clarified and that cannot be removed without adding, revising, or prioritizing a substantive normative premise.

Proposition 24.359 (Incommensurability non-paralysis). *Failure of complete commensurability does not imply that justice judgment or collective action is impossible, but any bounded decision procedure used in its place should disclose the normative priorities, exclusions, residual values, and authority relations through which action becomes determinate.*

The proposition also guards against forced commensuration. Institutions often need decisions, budgets, rankings, or eligibility rules. Practical determinacy can be necessary, but institutional necessity does not transform an imposed metric into a morally neutral measure of heterogeneous value.

24.14.9 Normative Underdetermination

The preceding subsections converge on a justice-specific form of normative underdetermination. A richly reconstructed economic configuration can remain compatible

with several serious normative interpretations. Equality can conflict with priority; rights can constrain aggregate benefit; relational non-domination can conflict with paternalistic protection; historical repair can conflict with present claims; generative opportunity can conflict with stability or ecological restraint. GRE can make these conflicts more visible, but greater descriptive detail does not mechanically select one normative theory.

Definition 24.360 (Justice normative-underdetermination set). A *justice normative-underdetermination set* is the set of serious normative frameworks or premise combinations that remain compatible with the materially relevant descriptive and causal evidence in a scoped inquiry yet yield different justice judgments, priorities, or recommended actions.

The set should not be inflated by including every imaginable moral claim. A framework belongs in the serious set only when its premises are coherent enough for the inquiry, its standing and comparison rules can be stated, and its application to the case can be made intelligible. Nor does underdetermination imply that all frameworks are equally defensible. Internal inconsistency, factual misapplication, arbitrary exclusion, self-defeating principles, or conflict with domain-specific rights and obligations can weaken particular positions. The point is narrower: the economic facts alone do not guarantee one remaining normative conclusion.

Definition 24.361 (Normative divergence locus). A *normative divergence locus* is the specific premise, priority relation, standing rule, threshold, baseline, aggregation rule, or procedural authority at which otherwise shared empirical reconstruction produces materially different justice conclusions.

Locating the divergence is often more productive than searching for an artificial consensus. Researchers can then distinguish disagreements about evidence from disagreements about moral standing, priority, responsibility, rights, or acceptable tradeoffs. The result can also guide empirical work: some normative disagreements become less consequential when a feasible alternative dominates across several serious frameworks, while other disagreements remain decisive even after extensive factual clarification.

Proposition 24.362 (GRE normative non-derivation). *GRE's descriptive concepts of relation, generativity, capability, power, conversion, circulation, stability, option structure, or historical transmission do not by themselves derive a unique justice judgment; any such judgment requires normative premises whose role, scope, and revisability should remain explicit.*

A later section generalizes this limitation beyond justice theory to GRE's normative claims more broadly. The present subsection establishes the justice-specific implication: normative underdetermination should be represented as part of the analysis rather than concealed behind technical vocabulary or one unmarked evaluative default.

24.14.10 Transfer Justice

Transfer justice concerns discrete or staged movements of resources, claims, rights, obligations, access, recognition, support, or other value-bearing conditions among

specified positions. Chapter 22 emphasized that formal sender and recipient are often insufficient to identify actual incidence. Transfers can pass through intermediaries, require conversion, alter dependency, affect third parties, impose administrative burdens, change local prices, generate later obligations, or interact with historical claims. The limitation is therefore a nominal-transfer fallacy: treating the declared amount or destination as if it exhausted the justice object.

Definition 24.363 (Transfer-justice limitation profile). A *transfer-justice limitation profile* records the transferred object, formal sender and recipient, contributors and intermediaries where relevant, eligibility, conditions, timing, conversion steps, administrative burdens, direct and indirect economic incidence, relational and generative effects, affected third parties, historical context, return or recirculation, practical alternatives, and the normative principles used to evaluate the transfer.

The distinction between transfer and repair is especially important. Compensation can improve material position while leaving a damaged relation, lost time, cultural loss, ecological damage, exclusion, or historical misrecognition substantially unaddressed. Conversely, symbolic recognition can matter while leaving material disadvantage untouched. A transfer can therefore be justified and beneficial without constituting complete repair, and repair can require institutional or relational change beyond transfer.

Proposition 24.364 (Transfer–repair non-equivalence). *Evidence that a transfer is adequate under a specified distributive or compensatory metric does not by itself establish that the underlying harm, relation, historical claim, lost capability, residual value, or future constraint has been adequately repaired.*

Conditional transfers create another limit. Conditions can support legitimate purposes such as verification, safeguarding, or coordination, but they can also impose surveillance, stigma, delay, behavioral control, or burdens that disproportionately reduce realized benefit. Universal and unconditional transfers are not automatically superior either; they can misallocate scarce resources or fail to address differentiated need. Justice requires comparison among feasible architectures rather than a categorical preference for one transfer form.

Third-party incidence can also be decisive. A housing subsidy can partly accrue to landlords through price changes. Remittances can redistribute care and bargaining burdens within households. Aid can strengthen implementing organizations or procurement networks. Debt relief can alter creditor and taxpayer positions. A transfer justice analysis should therefore track not only who formally receives the transfer but who ultimately gains, pays, controls, converts, captures, and inherits its consequences.

Definition 24.365 (Transfer-justice remainder). A *transfer-justice remainder* is any materially relevant justice claim concerning relation, recognition, participation, historical responsibility, residual value, third-party incidence, generative consequence, or future constraint that remains unresolved after the nominal transfer and its directly measured economic effects have been accounted for.

Proposition 24.366 (Justice-theoretical limitation principle). *A GRE justice analysis should reconstruct economic structures precisely and state its normative premises explicitly; richer description does not eliminate normative underdetermination.*

The principle closes the section by locating GRE's distinctive contribution and its limit. GRE can reveal justice-relevant mechanisms that disappear in a purely distributive snapshot: conversion barriers, circulation capture, recognition power, relational dependence, generative foreclosure, intergenerational transmission, residual value, and transfer incidence. These additions can materially change a normative judgment. They do not, however, transform GRE into a complete moral theory. Justice remains a domain in which richer economic reconstruction and explicit normative reasoning must remain coupled without being conflated. The next section turns from this theoretical limit to practical action, where institutions must intervene under incomplete knowledge, unintended consequences, irreversibility, value conflict, participation constraints, limited capacity, and radical uncertainty.

24.15 Limits of Applied Praxis

Chapter 10 developed application-dominant praxis as consequential action undertaken when knowledge, values, institutional conditions, and future consequences can remain incomplete. Chapter 11 then developed methodologies for diagnosis, decision, intervention, monitoring, adaptation, repair, exit, and rollback. The present section returns to that practical architecture after the preceding Chapter 24 analyses of epistemic limitation, historical reconstruction, formalization, heterogeneous value, power, and justice. Its role is not to restate methods for choosing interventions. Its objective is to specify the conditions under which applied GRE can become practically overconfident even when its descriptive and formal work is internally careful. The analysis proceeds through incomplete knowledge, unintended consequences, irreversibility, model risk, value conflict, participation limits, institutional capacity, and action under radical uncertainty. The governing method is relational and consequence-sensitive: the quality of an intervention depends not only on the correctness of a proposed target but also on who bears uncertainty, what can be monitored, what can be repaired, which alternatives remain available, which institutions can implement and revise the intervention, and which consequences of action or non-action become difficult to reverse.

Applied praxis creates a distinctive theoretical pressure because practical systems cannot always postpone commitment until research uncertainty has been resolved. Waiting can itself redistribute risk, preserve harmful trajectories, consume time, exhaust resources, normalize institutions, or foreclose later options. Yet urgency does not convert uncertainty into knowledge. The appropriate GRE response is therefore neither maximal caution nor maximal intervention by default. It is to connect the strength and reversibility of practical commitment to the quality of the available warrant, the severity and distribution of possible consequences, the capacity to observe and repair error, and the option structure retained after action.

Definition 24.367 (Applied-praxis limitation profile). An *applied-praxis limitation profile* records the practical objective, affected positions, evidential basis, unresolved uncertainty, serious rival interpretations, intervention mechanism, scale and timing, anticipated and unanticipated consequence channels, reversibility, repair capacity, value conflicts, participation architecture, institutional capability, monitoring conditions, non-action consequences, and reopening criteria that bound a GRE

Table 24.15: Principal limits of applied GRE praxis

Praxis problem	Characteristic overreach	Required GRE discipline
Incomplete knowledge	Urgency is treated as if it removes epistemic uncertainty	Match commitment to warrant, stakes, reversibility, monitoring, and consequences of delay
Unintended consequences	Unplanned effects are treated either as unforeseeable noise or as proof that intervention was mistaken	Reconstruct consequence pathways, adaptation, second-order effects, distribution, and learnability
Irreversibility	Formal rollback is equated with restoration of the prior practical state	Track material, institutional, relational, capability, ecological, and option-space irreversibility
Model risk	A useful model is treated as a sufficient practical representation of the intervention field	Record model purpose, omitted mechanisms, shared assumptions, decision sensitivity, and fallback pathways
Value conflict	One operational metric silently settles heterogeneous evaluative disagreement	Preserve protected values, residual disagreement, explicit priority rules, and revision authority
Participation limits	More participation is assumed to be always feasible, representative, or just	Match participation architecture to relevance, burden, capability, representation, power, and decision stage
Institutional capacity	A desirable intervention is assumed implementable because it can be specified	Test authority, competence, resources, coordination, monitoring, memory, repair, and continuation capacity
Radical uncertainty	Unspecifiable futures are converted into precise probabilities or used to justify arbitrary caution	Use robust, adaptive, reversible, plural, monitored, and revisable postures proportionate to stakes

intervention claim.

The profile extends the limitation grammar introduced in Section 24.1. A limitation in applied praxis is not equivalent to a reason for paralysis. It identifies where practical responsibility requires additional safeguards, narrower claims, staged commitment, alternative designs, stronger monitoring, or explicit acceptance of residual risk. Conversely, the presence of an implementation mechanism or formal authorization does not establish that the intervention is adequate. Praxis remains answerable to what happens after authorization, including adaptation, feedback, third-party incidence, institutional degradation, and later inability to revise the arrangement.

Table 24.15 summarizes the principal limits developed below.

24.15.1 Incomplete Knowledge

Incomplete knowledge is ordinary rather than exceptional in application-dominant praxis. The practical system can be only partly observed; causal mechanisms can remain disputed; historical analogies can be imperfect; affected positions can be incompletely represented; future conditions can change during implementation; and the intervention itself can generate evidence that did not exist beforehand. Section 24.3 treated these as epistemic limits. The applied problem is different: a practical commitment must often be made while those limits remain active.

The first danger is an *urgency conversion error*: because delay has costs, the decision process silently treats the need to act as if it increased confidence in the favored model. Urgency can lower the practical threshold for commitment when delay itself is dangerous, but it does not strengthen the underlying evidence. A decision made under time pressure should therefore carry its residual uncertainty into implementation rather than retrospectively redescribing the decision as epistemically settled.

Definition 24.368 (Decision-relevant ignorance profile). A *decision-relevant ignorance profile* records the materially consequential unknowns, uncertain mechanisms, unobserved affected positions, unresolved rival explanations, unknown response elasticities, uncertain temporal horizons, and possible missing categories whose variation could alter the ranking, design, timing, or reversibility of candidate practical responses.

The profile is intentionally narrower than a catalogue of everything unknown. Applied praxis becomes impossible if every metaphysical or empirical uncertainty is treated as decision-critical. The relevant question is which unknowns could materially change the practical conclusion. Some uncertainties affect only a fine-grained estimate while leaving the direction of action stable. Others change whether the intervention should proceed at all, which population should be protected, or whether a supposedly reversible pilot can create durable lock-in.

Incomplete knowledge also creates an asymmetry between acting and waiting that must be made explicit rather than assumed. In some cases, intervention generates irreversible harm while waiting preserves alternatives. In others, delay allows preventable harm, institutional reproduction, ecological degradation, capability loss, or infrastructure deterioration to continue. Non-action can therefore require the same evidential and normative scrutiny as action.

Definition 24.369 (Action–inaction consequence symmetry). *Action–inaction consequence symmetry* is the analytical requirement that a practical comparison represent materially relevant consequences of intervention, delay, continuation, refusal, and withdrawal under comparable temporal, distributive, and uncertainty conditions rather than treating the status quo as consequence-free by default.

The requirement does not imply moral equivalence between action and omission. It prevents the analytical baseline from receiving an unearned presumption of harmlessness. A policy change can create risk, but so can retaining an arrangement known to generate exclusion or environmental damage. A delayed infrastructure repair can preserve fiscal flexibility while increasing the probability of later failure. A moratorium can preserve options while also concentrating costs on positions dependent on timely access. The practical comparison should therefore state what is expected to continue if no new intervention occurs.

Proposition 24.370 (Incomplete-knowledge commitment condition). *When consequential action cannot reasonably await complete knowledge, the warrant for commitment should depend jointly on the best available evidence, the consequences of delay or non-action, the stakes and distribution of plausible error, the reversibility of the commitment, the capacity for monitoring and repair, and explicit conditions for reopening the decision.*

This proposition does not supply a universal decision formula. It specifies the dimensions that prevent incomplete knowledge from being converted either into false certainty or into indefinite postponement. The balance among them remains domain- and case-specific.

24.15.2 Unintended Consequences

Applied interventions act in relational systems whose participants adapt, interpret, resist, imitate, route around, or strategically use the intervention. Consequences can therefore arise outside the target mechanism even when the target mechanism is correctly specified. Price changes can redistribute benefits; eligibility rules can alter behavior; new infrastructure can change settlement patterns; a transparency rule can improve accountability while reducing candid internal deliberation; a safety requirement can create a compliance industry that later shapes the rule itself. Unintended consequences are not peripheral accidents. They are ordinary products of intervention into systems with feedback, heterogeneous positions, and changing relations.

The phrase nevertheless requires discipline. An unintended consequence is not simply any outcome the analyst failed to predict. The consequence can have been anticipated by affected participants but ignored by the decision authority. It can be foreseeable in kind but uncertain in magnitude. It can result from implementation failure rather than the intervention mechanism. It can be generated only after agents adapt to the policy. These cases carry different implications for responsibility and revision.

Definition 24.371 (Unintended-consequence profile). An *unintended-consequence profile* records an intervention's non-target effects, the positions affected, causal or generative pathway, temporal delay, scale, distribution, foreseeability at the decision point, whether the effect was represented by dissenting or peripheral participants, the role of adaptation or strategic response, and the available mitigation, repair, or reversal pathways.

The profile distinguishes unintended from unforeseen. A consequence can be unintended yet foreseen and accepted as a cost. It can be unforeseen by the authorized decision maker yet well understood by a local community. It can also be genuinely difficult to anticipate because the intervention changes the field in which later responses arise. This distinction matters for accountability. A system that repeatedly ignores known peripheral warnings has a different limitation from one that encounters a novel mechanism generated by the intervention itself.

A second limit concerns the interpretation of surprises. Unintended consequences do not automatically prove that the intervention was unjustified. A practically responsible intervention can generate an unforeseeable adverse effect despite proportionate safeguards. Conversely, a favorable surprise does not validate the decision process retroactively. Practical evaluation should distinguish the quality of ex ante judgment from the realized ex post outcome.

Definition 24.372 (Praxis surprise decomposition). A *praxis surprise decomposition* separates an unexpected outcome into errors or omissions in prior evidence, model specification, problem framing, implementation, participation, institutional coordination, adaptive response, exogenous change, and genuinely emergent consequence pathways that became identifiable only after intervention.

This decomposition supports learning without encouraging hindsight bias. If a harmful consequence followed from a documented but disregarded warning, the correction concerns decision architecture or power. If it followed from a model assumption known to be fragile, the correction concerns model risk. If it emerged through

a previously unavailable feedback loop, the correction may concern monitoring and adaptive capacity rather than culpable prior ignorance.

Proposition 24.373 (Unintended-consequence learning condition). *An unintended effect should revise GRE praxis when the reconstructed consequence pathway reveals a materially relevant mechanism, affected position, interaction, or adaptation that the prior intervention architecture omitted or misweighted; the required revision should target that omission rather than treating every surprise as either random noise or total failure of intervention.*

The proposition makes practical learning selective. Application can generate evidence, but the evidence becomes theoretically useful only when the pathway is reconstructed with enough specificity to alter later diagnosis, design, monitoring, or repair.

24.15.3 Irreversibility

Irreversibility raises the stakes of applied error because later knowledge can arrive after the relevant option has closed. Chapters 10 and 11 therefore treated rollback, option preservation, and adaptive revision as central practical capacities. Section 24.11 further distinguished irreversibility in value conversion. The present limit concerns intervention as a whole. A policy can be formally repealed while its infrastructural, ecological, institutional, relational, or capability effects persist.

Definition 24.374 (Practical irreversibility profile). *A practical irreversibility profile records which intervention effects can be undone, restored, compensated, substituted, or only partially repaired across material, ecological, institutional, legal, relational, informational, capability, financial, and option-space dimensions, together with the horizon and cost under which reversal remains feasible.*

The profile prevents formal rollback from being treated as restoration. A regulation can be revoked after firms have exited, skills have atrophied, infrastructures have been dismantled, or land use has changed. A platform can be replaced after network effects and data dependencies have reorganized an institution. A development project can compensate displaced persons without restoring lost social relations or ecological conditions. Reversibility is therefore multidimensional and position-dependent.

The opposite error is to treat every costly change as irreversible. High reversal cost can justify caution without establishing impossibility. Some effects can be repaired through time, investment, institutional redesign, or compensatory pathways. Others are irreversible within the horizon relevant to affected persons even if technically reversible over a century. The practical claim should therefore state the horizon and object of reversal.

Definition 24.375 (Reversibility reserve). *A reversibility reserve is the retained collection of alternatives, resources, competencies, records, interoperable infrastructures, legal authority, exit rights, relationships, ecological buffers, time, and repair pathways required to suspend, redirect, replace, or substantially repair an intervention before materially relevant options close.*

A reversibility reserve can decay during implementation. Staff leave, alternative

suppliers disappear, debt accumulates, data migrate into proprietary systems, communities reorganize, sunk costs increase, and political constituencies form around the intervention. An initially reversible pilot can therefore become practically durable through accumulation rather than one explicit commitment.

Proposition 24.376 (Irreversibility-sensitive commitment principle). *As the severity, distribution, or irreversibility of plausible adverse consequences increases, responsible applied praxis should demand stronger warrant or stronger protective architecture, including staged commitment, retained alternatives, monitoring, repair capacity, or other mechanisms proportionate to the stakes; urgency can modify but does not erase this burden.*

The principle remains deliberately non-algorithmic. Inaction can itself be irreversible, especially under ecological degradation, epidemic growth, infrastructure failure, or rapid capability erosion. The relevant comparison concerns competing irreversibilities, not intervention irreversibility in isolation.

24.15.4 Model Risk

Section 24.7 examined formalization limits at the level of theory and model construction. Applied praxis adds another problem: even a useful, empirically supported model can create practical risk when it is used outside its validated purpose, embedded in an institution that changes behavior, or treated as more complete than the decision requires. Model risk therefore concerns the relation between representation and commitment rather than model error alone.

Definition 24.377 (GRE praxis model-risk profile). *A GRE praxis model-risk profile records the model's practical purpose, target and boundary, evidential support, omitted mechanisms, parameter and category uncertainty, relevant alternative models, shared assumptions across the model family, intervention sensitivity to model variation, performative effects of model use, monitoring signals, and fallback or override pathways.*

A model can be excellent for forecasting one variable and poor for selecting an intervention because intervention changes the process that generated the historical data. A model can rank candidates accurately on average while systematically underrepresenting a small group whose welfare is normatively protected. A simulation can clarify possible mechanisms while lacking enough calibration for quantitative policy thresholds. A causal estimate can identify a local average effect while providing limited guidance about a scaled intervention under changed institutions. Model quality is therefore purpose-indexed.

Reliance on multiple models does not automatically resolve the problem. Models can share data, categories, omitted variables, institutional assumptions, or common historical training conditions. Apparent agreement can therefore reflect correlated representational error rather than independent corroboration, as Section 24.4 already established for representations more generally.

Definition 24.378 (Decision-model dependence). *Decision-model dependence is the degree to which a practical recommendation, intervention design, timing, target, or threshold changes under serious alternative model structures, parameteriza-*

tions, boundary choices, or assumptions that remain compatible with the available evidence.

High dependence does not make action impossible. It changes the design problem. An intervention can sometimes be chosen because it performs acceptably across several serious models, because it is easily reversible, or because monitoring can discriminate among the models after a bounded pilot. In other cases, one model-dependent recommendation carries enough irreversible downside that additional inquiry is warranted.

Proposition 24.379 (Model-use non-sufficiency). *The existence of a formally coherent, empirically useful, or comparatively successful model does not by itself justify the practical commitment derived from it; applied warrant additionally depends on decision-model sensitivity, omitted consequence channels, stakes, reversibility, institutional use, and the capacity to detect and correct model-induced error.*

This proposition also applies to GRE itself. Relational, network, field, dynamical, or history-based representations can illuminate intervention design while remaining one family of representations among others. Applied praxis should not privilege them merely because they fit the book's conceptual vocabulary.

24.15.5 Value Conflict

Applied praxis often requires a decision before value conflict has been resolved. Sections 24.9–24.14 showed why heterogeneous value, partial commensurability, residual value, and normative underdetermination cannot be eliminated simply by improving measurement. In application, however, budgets must be allocated, infrastructure located, eligibility defined, risks accepted or rejected, and timing chosen. Practical determinacy is therefore necessary even when evaluative determinacy is unavailable.

The first limit is procedural concealment. An institution can convert a substantive value conflict into a technical threshold, score, cost-benefit ratio, optimization objective, or administrative rule and then present the result as if the normative conflict had disappeared. The procedure can be necessary and legitimate, but its practical necessity does not make its priorities neutral.

Definition 24.380 (Applied value-conflict register). *An applied value-conflict register records the materially relevant value claims, affected positions, partial comparison relations, protected thresholds or rights, residual values, substantive disagreement, decision procedure, authority for setting priorities, burdens of compromise, and conditions under which the settlement should be reopened.*

The register preserves a distinction introduced in Section 24.9: settlement does not necessarily equal resolution. A planning authority can select one route after public deliberation while disagreement about landscape, livelihood, heritage, ecology, cost, or future development remains. A health institution can adopt a triage rule without proving that all competing ethical principles have been reconciled. Applied praxis requires closure sufficient for coordinated action while retaining the genealogy of that closure.

Value conflict also complicates experimentation. A reversible pilot can reduce epis-

temic uncertainty while still imposing concentrated burdens on a subgroup. Treating participants as merely sources of information can therefore convert epistemic benefit into an unacknowledged distributive or justice cost. Experimental value should remain one value among others.

Definition 24.381 (Protected-value floor). A *protected-value floor* is an explicitly justified practical constraint below which a specified value, right, capability, ecological condition, safety condition, or relational standing is not to be traded for improvement in other represented objectives within the current intervention architecture.

Protected floors are not intrinsically absolute. Some can admit emergency exceptions; others may be legally or morally stringent. Their analytical role is to make non-substitutability explicit where the applied framework claims it, rather than letting an aggregate objective silently override every dimension.

Proposition 24.382 (Practical settlement transparency condition). *When applied praxis must act amid unresolved value conflict, the decision architecture should distinguish the values that were compared, protected, subordinated, deferred, or left residual from the institutional procedure that produced practical closure; operational settlement should not be represented as proof of complete normative resolution.*

This condition makes later revision possible. If circumstances change, the institution can identify which priority rule or protected floor produced the earlier decision rather than treating the implemented outcome as a self-validating precedent.

24.15.6 Participation Limits

Participation is central to application-dominant praxis because affected positions can contribute local knowledge, value claims, problem definitions, implementation knowledge, and contestation. Yet participation itself has limits. Universal direct participation can be infeasible; repeated consultation can impose substantial time and emotional burdens; technical issues can require specialized knowledge; confidential information can constrain disclosure; some affected persons may lack the capacity or opportunity for direct participation; and highly organized participants can dominate processes that appear formally open.

The first analytical mistake is therefore to equate more participation with better praxis without specifying the function that participation is meant to perform. Participation in problem framing differs from participation in evidence production, value articulation, design, authorization, implementation, monitoring, appeal, or revision. Different positions can have different relevant standing across these stages.

Definition 24.383 (Participation-function profile). A *participation-function profile* records the practical stage, participating and non-participating affected positions, purpose of participation, mode of representation, information and accessibility conditions, decision influence, burden, compensation where relevant, power asymmetries, dissent preservation, and available contestation or appeal pathways.

The profile protects against symbolic participation. Attendance at a meeting, submission of comments, or formal membership on an advisory body does not establish consequential influence. Conversely, lack of direct co-decision does not always establish exclusion. A specialized safety decision can legitimately rely on expertise while

remaining answerable through transparency, oversight, appeal, or representation of affected interests.

Participation can also create ****participatory burden****. Communities facing repeated projects or crises can be asked to supply testimony, local knowledge, unpaid translation, emotional labor, or legitimacy to institutions whose underlying authority remains unchanged. Marginalized positions can be required to repeatedly demonstrate harm that institutions could have monitored themselves. A participation architecture should therefore evaluate who bears the cost of making the system knowable.

Definition 24.384 (Participation-capacity gap). A *participation-capacity gap* is the difference between a position's formal opportunity to participate and its practical capacity to make relevant knowledge, interests, reasons, objections, or proposals consequential within the decision process.

The gap can arise from time, language, expertise, disability, geography, digital access, legal insecurity, care responsibilities, organizational resources, agenda control, intimidation, or uncertainty about whether participation will matter. It can therefore be partly an economic and power problem rather than a procedural one alone.

Proposition 24.385 (Participation proportionality condition). *Applied GRE should evaluate participation relative to the practical function, stakes, affectedness, knowledge distribution, capacity, burden, power, reversibility, and available forms of representation or contestation rather than using maximal participation or formal inclusion as a universal proxy for responsible praxis.*

The proposition allows differentiated participation without treating expert or institutional authority as self-justifying. It requires the architecture of inclusion and exclusion to be stated and defended in relation to the decision object.

24.15.7 Institutional Capacity

An intervention can be normatively attractive, empirically plausible, and formally coherent while failing because the responsible institution cannot implement, monitor, maintain, coordinate, finance, interpret, or revise it. Chapter 10 treated collective capability as relational and institutional rather than as the sum of individual competence. Applied limitation analysis therefore has to ask whether the organization that is expected to act actually possesses the configuration of capabilities on which the intervention depends.

Definition 24.386 (Applied institutional-capacity profile). An *applied institutional-capacity profile* records the authority, resources, personnel, expertise, coordination, infrastructure, information access, implementation channels, monitoring capability, institutional memory, maintenance, repair, conflict-management, legitimacy, learning, and revision capacities required to carry an intervention through its relevant practical horizon.

Capacity is task-relative. An institution can have strong analytical capability and weak implementation capacity, strong implementation and weak monitoring, or strong emergency response and weak long-horizon maintenance. Aggregate labels such as "state capacity" or "organizational capability" can therefore conceal the exact stage at which the intervention becomes infeasible.

Capacity can also be endogenous to intervention. A program can build institutional competence through learning, infrastructure, coordination, and trust. It can also consume or degrade capacity by exhausting staff, creating fragmented systems, displacing local knowledge, or binding the institution to a provider it cannot later replace. Feasibility assessment should therefore consider both the capacity required at entry and the capacity generated or lost during operation.

Definition 24.387 (Institution–intervention capacity mismatch). An *institution–intervention capacity mismatch* occurs when an intervention’s requirements for authority, resources, coordination, implementation, monitoring, maintenance, repair, or revision materially exceed the responsible institution’s practical capabilities over the relevant horizon.

The mismatch is not always a reason to abandon the objective. It can motivate a smaller-scale intervention, staged implementation, capacity-building phase, simplified design, additional redundancy, external support, or transfer of responsibility. The key is that institutional capability becomes part of intervention design rather than an assumed background condition.

There is also a normative danger in capacity adaptation. Institutions can become more capable of implementing a harmful or unjust objective. Capacity is therefore not a master value. Its desirability depends on the actions, constraints, accountability, and purposes it enables.

Proposition 24.388 (Capacity-constrained praxis condition). *A practically justified intervention should be evaluated against the institutional capacity required not only to initiate it but also to monitor, maintain, contest, repair, revise, and, where relevant, discontinue it; where this capacity is absent, the intervention design or the institutional architecture should change before nominal authorization is treated as practical feasibility.*

This condition links capacity to responsibility. Institutions should not externalize foreseeable implementation failure onto affected positions while retaining the appearance that the policy itself was well designed.

24.15.8 Action under Radical Uncertainty

The preceding limits concern uncertainties that can often be represented through known alternatives, parameter ranges, scenarios, or model disagreement. Some practical situations are harder. Relevant mechanisms, future categories, actor types, technological possibilities, ecological thresholds, institutional reactions, or value conflicts can be only partly specifiable before action. The issue is not merely that probabilities are unknown. The set of relevant possibilities and the language in which they should be described can itself remain open, especially in the generative systems examined in Section 24.8.

Definition 24.389 (Radical practical uncertainty). *Radical practical uncertainty* is a condition in which materially relevant future states, mechanisms, categories, response types, or value implications cannot be specified with sufficient completeness and stability to support a determinate probabilistic decision model for the practical horizon at stake.

The definition should not be used whenever probabilities are inconvenient or data are sparse. Ordinary uncertainty, ambiguity, and model disagreement can often be analyzed directly. Radical uncertainty is a stronger claim about openness of the possibility or model space itself. It should therefore increase epistemic humility rather than license arbitrary intuition.

Action under radical uncertainty cannot rely on one universal rule. Precaution can protect against irreversible harm yet freeze harmful incumbencies; experimentation can generate evidence yet expose vulnerable groups or create lock-in; diversification and reversibility can preserve alternatives yet weaken coordination or durable investment. The appropriate response therefore depends on the stakes and domain.

Definition 24.390 (Radical-uncertainty response portfolio). A *radical-uncertainty response portfolio* is a case-specific combination of robustness, reversibility, modularity, diversity, redundancy, staged commitment, protected thresholds, monitoring, institutional learning, option preservation, dissent retention, repair capacity, and reopening rules used to govern action when the relevant future possibility space cannot be confidently closed.

The portfolio is not a checklist whose maximum score identifies the best intervention. Its elements can conflict and impose costs. The analytical task is to state why particular safeguards matter for the case and which risks they address.

Radical uncertainty also requires separating ex ante decision quality from ex post outcome. Responsible judgment can produce a poor result, while reckless judgment can benefit from favorable luck. Evaluation should therefore examine both without collapsing one into the other.

Definition 24.391 (Praxis reopening trigger). A *praxis reopening trigger* is a pre-specified or newly recognized condition, such as unexpected harm, changed evidence, institutional incapacity, model breakdown, value conflict, new affected positions, altered alternatives, loss of reversibility, or changed external conditions, whose occurrence requires material reconsideration of the intervention rather than routine continuation.

Reopening triggers matter because budgets, contracts, infrastructures, reputations, and political commitments can make revision harder as implementation proceeds. Responsible praxis therefore builds reconsideration into implementation from the beginning.

Proposition 24.392 (Applied-praxis adequacy principle). *Responsible GRE praxis does not require certainty before action, but the strength and durability of practical commitment should remain proportionate to evidential warrant, plausible harm, irreversibility, value conflict, participation and institutional capacity, the consequences of non-action, and the ability to monitor, repair, revise, or reopen the intervention as the relational field changes.*

The principle gives Chapter 24's limitation architecture a practical role. Applied GRE should neither postpone consequential commitment indefinitely nor use the need for commitment to suppress uncertainty. What remains unknown, contested, or institutionally fragile should remain visible in implementation and revision. The next section applies this discipline to domain transfer, where economic concepts can mislead when exported without reconstruction by the receiving domain.

24.16 Limits of Cross-Domain Transfer

Chapter 23 developed a disciplined architecture for interfaces between GRE and neighboring domains. It distinguished outward portability from universalization, inward contribution from conceptual capture, lexical recurrence from semantic equivalence, and shared empirical objects from domain-specific jurisdiction. The present section returns to those interface constructions from the perspective of limitation analysis. Its role is to identify where an economically useful concept, mechanism, or representation can become misleading when carried into history, governance, law, education, ecology, or artificial-intelligence studies without reconstruction by the receiving domain. The objective is not to discourage cross-domain inquiry. It is to specify the evidential and semantic burdens that must be satisfied before an economic construction is treated as portable. The analysis proceeds through six receiving domains, then develops false-generalization diagnostics and a domain-specific correction architecture. The governing method is asymmetrical in a deliberate way: GRE can propose a transferable analytical kernel, but the receiving domain retains authority over the constitution of its objects, admissible evidence, domain-specific values, standing rules, temporal scales, and correction standards.

Cross-domain transfer creates a distinctive limitation because apparent success can occur before conceptual adequacy has been established. An economic vocabulary can organize a new problem, generate a productive question, or reveal an overlooked mechanism while simultaneously distorting the receiving domain if its original semantics are preserved too strongly. Terms such as allocation, value, conversion, circulation, participation, constraint, power, institution, capability, and efficiency can all travel, but what counts as their object and warrant can change materially across domains. A useful transfer must therefore preserve enough structure to remain analytically informative while allowing enough reconstruction for the receiving domain to refuse, modify, or retype what was imported.

Definition 24.393 (Domain-transfer limitation profile). A *domain-transfer limitation profile* records the GRE construction proposed for transfer, its source-domain semantics and warrant, the receiving domain and problem, the portable analytical kernel, the receiving-domain reconstruction, changed or rejected assumptions, non-transferable components, translation losses, domain-specific remainders, correction authority, and conditions under which the transfer should be narrowed, retyped, or abandoned.

The profile converts cross-domain use from metaphorical borrowing into an accountable research relation. It also prevents repeated usefulness from being counted automatically as independent evidence for a general theory. If several receiving domains adopt a concept because they inherited the same GRE or GR vocabulary, the recurrence can remain designed rather than independently discovered. Chapter 23 treated this as a shared-origin problem in cross-domain generalization. The present section asks the narrower practical question: what can go wrong before any such generalization is attempted?

Table 24.16 summarizes the principal transfer risks developed below.

Table 24.16: Principal limits of cross-domain transfer from GRE

Receiving main	do-	Characteristic transfer error	Required discipline
History		Economic categories are projected backward or treated as historically invariant	Reconstruct historical categories, archives, temporal regimes, and formation processes before importing economic semantics
Governance		Allocation, incentives, or efficiency are treated as sufficient descriptions of authority and collective coordination	Reconstruct legitimacy, public authority, implementation, participation, and institutional response capacities
Law		Practical control or economic incidence is treated as equivalent to legal validity, status, entitlement, or obligation	Preserve constitutive legal categories and source-domain authority over legal interpretation
Education		Learning, formation, or educational quality is reduced to capability production, productivity, or economic return	Preserve educational aims, pedagogical relations, epistemic development, and domain-specific evaluative standards
Ecology		Ecological systems are represented primarily through human valuation, resource flows, or economic substitutability	Preserve biophysical constraints, ecological dynamics, non-economic value, irreversibility, and domain-specific standing questions
AI studies		Technical performance or model output is translated directly into economic agency, capability, dependence, or authority	Reconstruct technical conditions, system boundaries, deployment context, human mediation, verification, and domain-specific agency claims
Cross-domain generalization		Repeated vocabulary or apparent structural resemblance is treated as domain-independent identity	Test semantic, causal, evidential, temporal, and normative correspondence and retain failed transfers as evidence
Domain correction	correc-	Receiving-domain objections are treated as external commentary rather than revision pressure on GRE	Record correction provenance and propagate revisions to the GRE claims that materially depend on the failed transfer

24.16.1 Economics to History

Economic analysis often contributes useful questions to historical inquiry. Allocation, scarcity, institutional incentives, distribution, labor organization, market formation, value conversion, and circulation can illuminate material conditions and relational transformations that purely event-centered narratives might understate. Yet the transfer becomes limiting when contemporary economic categories are projected backward as if their identity, boundaries, or causal roles were historically invariant.

The first problem is category anachronism. A historical record can contain transactions, labor, obligations, property-like relations, exchange ratios, or administrative accounts without thereby instantiating the same concepts of market, wage labor, ownership, household, enterprise, value, productivity, or economic subject that operate in a later institutional setting. The same lexical label can also persist while its legal, social, political, or religious constitution changes. Historical transfer therefore requires category reconstruction before economic comparison.

Definition 24.394 (Historical transfer reconstruction). A *historical transfer reconstruction* records the historical period and scale, contemporary categories used by relevant actors and institutions, later analytical categories introduced by the researcher, archival basis, missing-record conditions, legal and institutional constitution, temporal regime, and the bridge by which a GRE concept is mapped onto the historical object.

The bridge matters because historical evidence is itself selective. Surviving prices,

contracts, tax records, account books, or administrative classifications can make some economic relations unusually visible while leaving household care, informal exchange, coercion, ecological dependence, ritual obligations, or unrecorded labor comparatively obscure. A transfer that follows only the archive's most quantified traces can therefore mistake documentary visibility for historical centrality.

Economic categories can also create retrospective causal compression. If a later institutional outcome is known, earlier relations can be redescribed as steps toward that outcome even when actors faced several plausible alternatives. The non-teleological discipline developed in Section 24.6 therefore applies directly to transfer. Economic explanations can identify material and institutional constraints without converting historical development into an optimization path or treating realized institutions as necessary equilibria.

Proposition 24.395 (History-transfer adequacy condition). *A GRE construction transferred into historical inquiry is adequately warranted only when its object, category semantics, temporal scale, evidential basis, and causal role have been reconstructed for the historical setting rather than inferred from lexical similarity, surviving quantitative records, or the later existence of an economic institution.*

The condition permits comparative economic history while limiting retrospective economicization. A historical domain can accept the transferred question and reject the source-domain category, or retain the category while revising its mechanism. Such rejection is informative rather than a failure of interdisciplinarity.

24.16.2 Economics to Governance

Governance is another domain in which economic constructions travel easily. Incentives, resource allocation, transaction costs, capability, institutional capacity, information asymmetry, collective goods, and distributional incidence can all improve analysis of public action. The transfer becomes limiting when governance is reconstructed as if collective coordination were exhausted by incentive-compatible allocation among already specified actors and preferences.

Governance can involve authority, legitimacy, representation, administrative competence, public justification, conflict management, jurisdiction, participation, emergency power, rule revision, and institutional memory. These objects are economically consequential but are not constituted by economic consequences alone. An intervention can be efficient under a declared objective and still be politically illegitimate, legally unauthorized, administratively infeasible, or incapable of sustaining compliance and contestation.

Definition 24.396 (Governance transfer remainder). *A governance transfer remainder records governance-relevant properties not established by the imported GRE construction, including public authority, legitimacy, jurisdiction, representation, participation, administrative capability, procedural requirements, contestability, and institution-specific response dynamics.*

The remainder is especially important for allocation language. GRE can analyze who receives resources, which relations are strengthened, whose capabilities are expanded, and how burdens are distributed. Those findings can be essential to gover-

nance analysis. They do not determine who is entitled to decide, what institutional procedure is valid, or whether the allocation rule is legitimate.

The transfer can also fail dynamically. Economic models sometimes treat an institution as a stable rule environment within which agents respond. Governance inquiry may instead need to explain how the rule-making body itself learns, fragments, delays, competes across jurisdictions, loses capacity, or changes its objective. The fast-slow caution of Section 24.6 is relevant here: an apparently slow institutional layer can change quickly during crisis, while supposedly flexible economic behavior can be locked into infrastructure or legal obligations.

Proposition 24.397 (Governance-transfer non-exhaustion). *Economic incidence, incentive structure, allocation efficiency, or capability effects can establish important governance-relevant facts, but none of these findings alone establishes public authority, legitimacy, procedural adequacy, administrative feasibility, or justified collective rule.*

The proposition preserves a productive interface. GRE can diagnose consequences and mechanisms while governance analysis retains authority over the additional predicates that make collective rule a governance object rather than merely an allocation problem.

24.16.3 Economics to Law

The economic-legal interface creates particularly strong transfer temptations because legal relations often shape ownership, exchange, liability, contract, organization, labor, inheritance, finance, and public provision. GRE can analyze how legal arrangements alter capabilities, conversion interfaces, circulation paths, power, and distribution. The limit appears when these practical effects are treated as if they constituted legal validity or legal status.

Practical control and legal entitlement can diverge. A party can possess de facto control without valid title; a legal right can exist without effective practical capacity to exercise it; contractual language can create formal obligations while enforcement, interpretation, or public-law constraints alter its practical effect. Economic models that collapse these distinctions can misidentify both the legal object and the economic mechanism.

Definition 24.398 (Legal transfer dependency). *A legal transfer dependency exists when a GRE claim materially depends on a legal category, status, validity condition, right, duty, jurisdiction, remedy, or authoritative interpretation whose warrant is supplied by legal sources and methods rather than by economic evidence alone.*

The dependency should remain visible after incorporation. If the legal interpretation changes, the GRE claim built on it may require revision. This is not a defect. It is the appropriate consequence of using an externally warranted constitutive premise.

A second danger is functional replacement. If two legal forms produce similar economic effects under one observation window, an economic analysis can be tempted to treat them as equivalent. Yet legal forms can differ in standing, remedies, procedural protections, third-party effects, default rules, public-law constraints, or future interpretive possibilities. Economic equivalence under one outcome measure there-

fore does not establish legal equivalence.

Proposition 24.399 (Law-transfer authority condition). *When GRE imports or evaluates a legal category, economic evidence may establish incidence, incentives, practical control, distribution, or capability consequences, but legal validity, legal identity, authoritative interpretation, and legal obligation remain dependent on the relevant legal sources, institutions, and interpretive practices.*

The condition also limits normative overreach. An economically efficient legal arrangement is not thereby legally legitimate or normatively justified. Conversely, a legal rule with substantial economic cost can remain binding or justified for reasons not reducible to economic welfare. Cross-domain transfer should preserve these possibilities rather than force one domain's evaluative grammar onto the other.

24.16.4 Economics to Education

Educational processes have obvious economic consequences. Education can influence capability, labor opportunity, innovation, social mobility, epistemic participation, institutional competence, and long-horizon development. GRE therefore has good reason to analyze educational relations as generative economic conditions. The transfer becomes limiting when educational aims are identified with economic capability production or when measurable economic return is treated as a sufficient proxy for educational value.

Education can involve understanding, judgment, curiosity, disciplinary formation, aesthetic and moral development, social participation, identity, interpretation, epistemic autonomy, and relations among teachers, learners, institutions, communities, and bodies of knowledge. Some of these objects have economic effects. Their educational quality is not established by those effects.

Definition 24.400 (Educational transfer remainder). *An educational transfer remainder records learning aims, pedagogical relations, forms of understanding, judgment, curiosity, epistemic autonomy, developmental conditions, disciplinary standards, and other educational qualities whose adequacy is not established by the economic capabilities or returns associated with them.*

The distinction is especially important when generativity is used. A learning environment can generate economically useful skills while narrowing curiosity, weakening judgment, excluding forms of knowledge, or creating dependence on externally supplied cognitive infrastructure. Conversely, an educational practice with low short-run market return can generate long-horizon intellectual, civic, cultural, or scientific capacities whose economic effects are indirect or uncertain.

The same caution applies to measurement. Completion rates, test scores, earnings, publication counts, or platform activity can function as manifestations of some educational processes while omitting others. Section 24.4's representation limits therefore constrain any transfer from measurable economic or administrative outputs back to claims about educational quality.

Proposition 24.401 (Education-transfer dual-warrant condition). *A GRE claim about educational generativity should distinguish the economic capabilities or consequences that GRE can analyze from the educational quality, learning, judgment, or developmen-*

tal claims that require educationally appropriate evidence and evaluative standards.

The dual warrant permits a strong economic analysis of education without reducing education to human-capital production. It also allows educational theory to correct GRE when an economically attractive intervention degrades the relations or capacities that constitute educational practice.

24.16.5 Economics to Ecology

Ecological transfer creates some of the most consequential limits because economic systems depend on material and ecological conditions while economic valuation can make those dependencies appear commensurable with other represented objectives. GRE improves on simple scalar valuation by allowing heterogeneous value, ecological constraints, non-commensurable remainders, and relational dependence. Even so, economic vocabulary can still overreach if ecological processes are reconstructed primarily through human benefits, resource flows, substitution possibilities, or institutional prices.

Ecological systems possess dynamics, thresholds, material constraints, metabolic relations, evolutionary histories, and irreversible changes that are not created by economic recognition. Economic actors can ignore a biophysical constraint without removing it. A price can change without the ecosystem improving, and an ecosystem can deteriorate without producing an immediate price signal. Economic manifestation therefore remains only one access channel to ecological change.

Definition 24.402 (Ecological transfer boundary). *An ecological transfer boundary identifies the point at which a GRE representation of ecological dependence, value, resource use, conversion, circulation, or constraint requires ecological premises concerning system dynamics, thresholds, material processes, species or habitat conditions, irreversibility, and other biophysical relations that economics cannot independently establish.*

The boundary is not a division between nature and economy. Economic institutions can alter ecological conditions profoundly, while ecological change can reorganize economic possibility spaces. The point is epistemic and disciplinary: the causal and constitutive claims about ecological systems require ecological evidence and concepts appropriate to those systems.

A further danger concerns substitution. Even when two interventions yield similar economic value under a declared metric, their ecological effects can differ in reversibility, resilience, trophic relations, spatial distribution, or future option structure. Compensation elsewhere in the economic system does not automatically restore the affected ecological relation. Sections 24.9 and 24.10 therefore constrain ecological aggregation and commensuration.

Proposition 24.403 (Ecology-transfer non-substitution condition). *Economic compensation, price equivalence, or aggregate value replacement should not be treated as ecological restoration or ecological equivalence unless the relevant ecological relations, functions, thresholds, temporal dynamics, and irreversibilities are independently shown to support that inference.*

This condition permits economic analysis of environmental incidence while pre-

serving ecological correction authority. It also prevents GRE's own heterogeneous-value language from becoming a way to name ecological values without doing the ecological work required to establish them.

24.16.6 Economics to Artificial-Intelligence Studies

Artificial-intelligence studies create a different transfer problem because technical objects can be rapidly incorporated into economic systems before their technical boundaries, failure modes, or human-machine divisions of labor are stable. GRE can analyze capability asymmetry, dependence, conversion of technical capability into economic capability, platform concentration, workflow integration, epistemic mediation, and institutional consequences. The transfer becomes limiting when technical performance is translated directly into claims about agency, autonomy, economic capability, authority, or dependence.

An AI system is not a single homogeneous causal object. Model architecture, training data, inference infrastructure, interfaces, retrieval systems, tool use, organizational workflow, permissions, human review, deployment environment, monitoring, and update procedures can all matter to observed performance. A benchmark result or model-level capability can therefore fail to describe the deployed system that produces the economic consequence.

Definition 24.404 (AI transfer decomposition). An *AI transfer decomposition* records the technical system boundary, model and infrastructure components, deployment configuration, human roles, permissions, data and tool access, verification architecture, organizational mediation, failure modes, and the specific bridge by which a technical capability is claimed to become economically consequential.

The decomposition protects against capability inflation. A system can perform a task under benchmark conditions while lacking the access, reliability, permissions, complementary resources, or organizational integration required for economic realization. Conversely, modest model-level improvements can produce large economic effects when deployment changes coordination, scale, or bargaining positions.

Agency language requires additional restraint. Functional selection or automated action can be economically consequential without settling consciousness, moral standing, legal personality, political membership, or philosophical agency. Similarly, institutional use of AI can redistribute practical authority without proving that legal or political authority has been delegated to the system itself.

Proposition 24.405 (AI-transfer bridge condition). A *transfer from technical AI evidence to a GRE claim about economic capability, dependence, power, participation, or institutional effect should identify the deployment and organizational mechanisms through which the technical property becomes economically consequential; technical performance alone does not establish the stronger economic or normative predicate.*

This condition gives AI studies continuing correction authority. Technical evidence can overturn an economic narrative that assumes capabilities the deployed system does not possess, while GRE can show how apparently modest technical properties become consequential through concentration, institutional design, access, or dependence.

24.16.7 False Generalization

The six domain interfaces reveal a common danger: a concept can travel successfully enough to appear general while the apparent generality is produced by shared vocabulary, selective examples, similar institutions, or redefinition of the receiving-domain object until it fits the source concept. Chapter 23 distinguished designed recurrence from discovered recurrence. Domain-transfer limitation analysis adds a more local question: how can a false generalization be recognized before it becomes part of GRE's theoretical vocabulary?

One warning sign is **semantic stretching**. A concept is preserved by gradually weakening its meaning until almost any receiving-domain phenomenon qualifies. If allocation comes to mean any difference in conditions, value any significance, power any causation, institution any persistent pattern, or generativity any change, cross-domain recurrence becomes trivial. Portability purchased through semantic emptiness is not strong generalization.

A second warning sign is **success-conditioned sampling**. Researchers can preferentially discuss domains where a GRE concept appears useful and treat failures as irrelevant edge cases. Yet failed transfers can reveal the exact assumptions that make a concept economic rather than general. They are therefore comparative evidence and should remain visible in the transfer portfolio.

Definition 24.406 (False-generalization profile). A *false-generalization profile* records lexical recurrence, source-domain dependence, shared conceptual ancestry, semantic stretching, selective case inclusion, receiving-domain reconstruction, failed transfers, counterexamples, non-transferable assumptions, historical variation, and whether the proposed cross-domain structure retains enough content to discriminate among alternatives.

False generalization can also arise from formal resemblance. Two domains can admit similar graphs, operators, optimization problems, dynamical structures, or category-theoretic representations without sharing causal mechanisms or ontological commitments. Section 24.7's mathematical-transfer discipline therefore applies directly. Structural similarity warrants a comparative question, not automatic mechanism identity.

Proposition 24.407 (Cross-domain generalization burden). A GRE construction should receive stronger cross-domain status only when its recurrence survives receiving-domain reconstruction, meaningful semantic constraints, serious counterexamples, failed-transfer analysis, historical variation where relevant, and comparison with alternative structures that could explain the apparent recurrence.

The burden is intentionally demanding because a future GRT should not be produced by exporting GRE vocabulary and then counting its reappearance as confirmation. Cross-domain comparison becomes informative when receiving domains can genuinely resist the transfer.

24.16.8 Domain-Specific Correction

Cross-domain transfer becomes epistemically productive only when the receiving domain can correct the source framework. Otherwise GRE can borrow examples and

vocabulary while retaining authority over every interpretation. The limitation perspective therefore requires a failed or revised transfer to propagate back into the GRE claim that materially depends on it.

A receiving domain can reject the transferred object, narrow its scope, revise its semantics, identify a missing constitutive condition, supply counterevidence, distinguish collapsed mechanisms, or require an external normative warrant. Such correction need not revise GRE globally; the appropriate unit is the materially dependent claim.

Definition 24.408 (Domain-correction propagation record). A *domain-correction propagation record* identifies the receiving-domain correction, its evidential or conceptual basis, the transferred GRE construction affected, the downstream GRE claims that materially depend on it, unaffected claims, required retyping or narrowing, and the conditions under which the revised transfer could later be reconsidered.

The record prevents both insulation, in which criticism is acknowledged without altering the economic claim, and indiscriminate collapse, in which one failed transfer is treated as refuting unrelated GRE analyses. Dependency-sensitive revision avoids both errors.

Correction authority should be linked to the kind of claim at issue rather than to disciplinary prestige. Ecological, legal, educational, or technical premises remain answerable to the domains that can warrant them, while GRE remains responsible for how those premises are transformed into economic analysis.

Definition 24.409 (Cross-domain correction authority). *Cross-domain correction authority* is the claim-specific responsibility of a receiving domain to evaluate the objects, evidence, semantics, mechanisms, or normative warrants that fall within its problem-space, together with GRE's responsibility to revise economic conclusions when those externally warranted premises materially change.

Correction authority does not create disciplinary veto over every mixed-domain claim. Many questions are genuinely joint. Its purpose is to prevent GRE from treating economic consequences as sufficient warrant for predicates constituted elsewhere.

Proposition 24.410 (Revisable domain-transfer principle). *Cross-domain transfer in GRE should remain typed, provenance-preserving, and revisable: the source framework may propose analytical kernels and economic consequences, the receiving domain retains authority over domain-specific constitution and warrant, and corrections should propagate to the GRE claims that materially depend on the transferred premise without requiring either disciplinary absorption or indiscriminate theoretical collapse.*

A transfer is not successful because GRE can describe another domain in its own language. It is successful when the borrowed construction survives receiving-domain reconstruction, remains open to correction, and makes failed transfers informative about GRE's boundaries. The next section applies this discipline to AI-era conditions, where technical change, opacity, concentrated infrastructure, epistemic dependence, and shifting capability boundaries can destabilize both transfer and internal GRE diagnosis.

24.17 AI-Era Limits

Chapters 17 and 18 examined artificial intelligence as part of the epistemic economy, artificial productive capacity, capability asymmetry, dependence, ownership, participation, and long-horizon economic order. Chapter 23 then placed GRE in an explicit interface with artificial-intelligence studies, preserving technical, economic, legal, political, educational, social, ethical, and ontological questions as separately warranted even when they are mutually conditioning. The role of the present section is different. It asks where the rapid incorporation of artificial systems creates limits for GRE's own claims, representations, and practical recommendations. The objective is not to treat artificial intelligence as uniquely unknowable or historically unprecedented. It is to identify a configuration in which technical capabilities, deployment architectures, verification burdens, human skills, synthetic representations, organizational routines, and institutional rules can change quickly enough that an economically adequate description becomes unstable while it is being used. The analysis proceeds through capability asymmetry, epistemic dependence, model opacity, delegated judgment, synthetic evidence, accelerated theory production, attention and orientation, and institutional dependence. The governing method is trajectory-sensitive: an AI-era GRE claim should specify not only the observed configuration but also which parts of that configuration are version-dependent, institution-dependent, capability-dependent, or vulnerable to rapid reclassification.

The AI-era limitation is therefore partly a problem of moving analytical boundaries. A model that is non-substitutable in one period can become widely available later. A workflow that appears to preserve human expertise can gradually externalize intermediate judgment. A proprietary infrastructure can become a practical bottleneck even while model-level competition increases. Verification procedures can lag behind symbolic production. Institutional rules can stabilize around a technology whose capabilities and failure modes continue to change. These processes do not imply one inevitable direction. They create a stronger burden to separate current performance from retained capability, present dependence from future substitutability, technical opacity from institutional unaccountability, and rapid production from warranted knowledge.

Definition 24.411 (AI-era limitation profile). An *AI-era limitation profile* records the artificial systems and supporting infrastructures relevant to a GRE claim, their version and deployment context, affected human and organizational capabilities, verification and fallback arrangements, dependency and concentration structure, institutional rules, expected rates of change, and the conditions under which the economic interpretation should be retested, narrowed, or withdrawn.

Definition 24.411 prevents an AI-related economic conclusion from being detached from the technical and institutional configuration that made it true. It also clarifies why statements about “AI” often age badly: the named object can conceal a changing stack of models, interfaces, retrieval systems, data pipelines, compute, human review, organizational practice, legal permissions, and infrastructure providers. A limitation analysis therefore has to preserve enough configuration detail for later re-epistemization.

Table 24.17 summarizes the eight limitation domains developed below.

Table 24.17: Principal AI-era limits for GRE analysis

Limitation domain	Characteristic analytical risk	Required discipline
Capability asymmetry	Technical performance is treated as a stable measure of economic capability or power	Reconstruct access, complements, substitution, persistence, infrastructure, and capability trajectories
Epistemic dependence	Current performance gains obscure loss of verification, reconstruction, or fallback capacity	Track retained human and institutional epistemic agency across repeated use
Model opacity	Limited system intelligibility is treated either as total unknowability or as irrelevant to consequential use	Identify the source of opacity, consequence-specific evidence needs, and compensating controls
Delegated judgment	Automated recommendation or execution is treated as transfer of responsibility, authority, or normative warrant	Separate task delegation, judgment delegation, institutional authority, accountability, and retained challenge capacity
Synthetic evidence	Generated, simulated, reconstructed, or transformed artifacts acquire evidential standing through surface plausibility	Type the artifact, preserve provenance, verify the evidential bridge, and prevent circular validation
Accelerated theory production	High-throughput hypothesis and formal production is treated as proportional growth in warranted theory	Preserve source verification, derivational completeness, discrimination among rivals, and independent empirical testing
Attention and orientation	Abundant outputs widen the candidate field while narrowing practical attention around machine-mediated rankings or framings	Track visibility, filtering, agenda formation, orientation diversity, and excluded alternatives
Institutional dependence	AI becomes embedded in workflows faster than substitution, audit, preservation, procurement, or governance capacity develops	Reconstruct stack-level dependence, concentration, exit, continuity, institutional memory, and adaptation lag

24.17.1 Capability Asymmetry

Capability asymmetry was developed earlier in the book as a multidimensional and relational condition rather than as a benchmark ranking. The AI-era limit arises because the relevant capability boundary can move rapidly and because capability becomes economically consequential only through a surrounding conversion architecture. Technical performance, model access, compute, data, organizational integration, complementary human skill, legal permission, verification, and institutional standing can change at different rates. A static comparison can therefore misidentify both the location and durability of asymmetry.

Definition 24.412 (AI capability-boundary volatility). *AI capability-boundary volatility* is the degree to which the tasks, quality thresholds, costs, access conditions, complementary requirements, and substitution possibilities relevant to an AI-mediated economic capability change within the horizon of the GRE claim.

A volatile boundary complicates statements such as “AI can perform task X” or “position A has an AI advantage over position B.” Performance may depend on a particular model version, retrieval configuration, tool chain, prompt protocol, data environment, latency tolerance, human reviewer, or price. A capability that is economically significant at one threshold can be irrelevant at another. Conversely, a modest technical improvement can have large economic effects where it crosses an institutional acceptance threshold or eliminates a bottleneck.

Proposition 24.413 (Capability-asymmetry revalidation condition). *An AI-related capability-asymmetry claim requires revalidation when material changes in technical performance, access, complementary resources, substitution, verification, infrastruc-*

ture, or institutional acceptance alter the pathway by which the capability becomes economically consequential.

The proposition makes capability asymmetry historical. A previously concentrated capability can diffuse while dependence remains because workflows and records have become provider-specific. A widely accessible model can coexist with concentrated compute, data, distribution, or organizational integration. An apparent technical equalization can therefore leave the economic field highly asymmetric at another layer.

This is also where human skill complementarity and atrophy enter the analysis. AI use can increase a person's practical capability by supplying translation, search, drafting, simulation, coding, or critique. Repeated use can also externalize some intermediate skills. These trajectories can coexist: a researcher may lose speed at unaided routine coding while gaining broader capacity for experimental design. The relevant limit is not whether skill has simply risen or fallen, but whether the capability profile required for later verification, adaptation, independent reconstruction, and participation remains adequate.

Definition 24.414 (Human–AI capability trajectory profile). A *human–AI capability trajectory profile* records, across repeated use, which human capabilities are complemented, newly generated, externalized, weakened, retained for verification, or made dependent on particular artificial and infrastructural supports, together with the consequences for later substitution and independent action.

A present productivity gain therefore cannot establish a favorable long-horizon capability trajectory. Nor does observed deskilling establish net capability loss where new higher-order capacities are generated. GRE should keep current output, distributed capability, retained fallback, and future learning as separate objects.

24.17.2 Epistemic Dependence

AI-mediated epistemic dependence arises when economically consequential functions of retrieval, synthesis, interpretation, classification, generation, or inference become difficult to perform, verify, contest, or reconstruct without artificial support. Earlier chapters emphasized that such dependence can be productive specialization rather than a defect. The limit emerges when present performance becomes easier to observe than the retained capacity required for later challenge and recovery.

The production of candidate outputs can scale more rapidly than human or institutional capacity to verify them. Chapter 17 described this as a relocation of scarcity under epistemic abundance. In AI-mediated settings the gap can become especially consequential because generation and verification have different cost structures. Fluent outputs can be produced quickly while source checking, replication, domain interpretation, and accountability remain comparatively slow. Symbolic abundance can therefore increase rather than reduce the economic value of provenance, trusted institutions, and verification capacity. Simon's analysis of information-rich environments remains relevant because abundance can intensify scarcity in the attention required to process available information (Simon 1971).

Definition 24.415 (AI verification-capacity gap). An *AI verification-capacity gap* is a

persistent difference between the scale, speed, or complexity of AI-mediated claims entering an economically consequential process and the practical human or institutional capacity available to check their provenance, standing, assumptions, failure conditions, or consequences at the level required by that process.

The definition is intentionally process-relative. A brainstorming system can tolerate a wide gap because unverified outputs may remain provisional. A clinical, legal, scientific, financial, or public-administrative function can require much stronger verification. The same model can therefore generate different dependence risks across uses.

Proposition 24.416 (Epistemic performance and agency). *Improved AI-mediated epistemic performance does not establish preserved epistemic agency if reliance materially reduces access to sources, alternative interpretations, consequential verification, contestation, process reconstruction, or continuation under plausible changes in support.*

The proposition also guards against a simplistic autonomy ideal. No complex epistemic system is fully self-sufficient. The relevant question is which capabilities must remain distributed across humans, organizations, professions, public bodies, and technical infrastructures for the function to remain contestable and recoverable. The answer can differ by consequence and by institutional design.

A further limit concerns dependence measurement. Usage frequency is not sufficient. High-frequency use can remain weak dependence when alternatives are cheap and records are portable. Occasional use can create strong dependence when a rare AI-mediated function is a non-substitutable bottleneck. GRE should therefore evaluate verification, substitution, exit, reconstruction, and continuity rather than infer dependence from adoption alone.

24.17.3 Model Opacity

Model opacity is often discussed as if it were one property. For GRE, that treatment is too coarse. Opacity can arise from technical complexity, inaccessible training or system information, proprietary restrictions, rapidly changing versions, interaction among multiple components, stochastic behavior, undocumented human procedures, or the difficulty of interpreting which internal feature matters for a particular outcome. Burrell's analysis is useful precisely because it distinguishes several sources of opacity rather than treating algorithmic inscrutability as a single condition (Burrell 2016).

Definition 24.417 (Consequence-relative opacity profile). A *consequence-relative opacity profile* records which parts of an AI-mediated process are inaccessible, unintelligible, unstable, or difficult to reconstruct; the source of each opacity; the economic consequence for which understanding is required; available behavioral, documentary, provenance, monitoring, audit, or contestation evidence; and the residual uncertainty that remains after those compensating measures.

This profile prevents two symmetrical errors. One is to conclude that an opaque model is unusable because complete internal understanding is unavailable. The other is to conclude that internal opacity is irrelevant whenever average performance is adequate. The relevant burden depends on what the system is allowed

to do, what harms or dependencies are plausible, whether affected positions can challenge outcomes, and whether behavior can be reconstructed after failure.

Documentation and provenance can reduce some forms of opacity without revealing every internal mechanism. Datasheets and related documentation practices illustrate how structured information about data and system context can improve accountability without pretending to provide exhaustive understanding (Gebru et al. 2021). Audit can likewise test declared properties and institutional use without requiring complete transparency. Kroll and colleagues emphasize that accountability can depend on verifiable properties and procedural mechanisms rather than on a single ideal of explanation (Kroll et al. 2017).

Proposition 24.418 (Opacity compensation limit). *Behavioral testing, documentation, provenance, monitoring, audit, and contestability can compensate for some consequence-relevant opacity, but they do not eliminate residual uncertainty when material failure conditions, update effects, or deployment interactions remain outside the evidence inspected.*

Opacity therefore becomes a GRE limit when the institution's confidence or delegation exceeds what its evidence can support. The relevant remedy can be narrower use, stronger monitoring, redundant pathways, independent review, or retained human expertise rather than universal disclosure.

24.17.4 Delegated Judgment

Artificial systems can be incorporated into activities previously described as human judgment: ranking applicants, detecting anomalies, recommending treatments, allocating attention, drafting legal or policy analysis, selecting research questions, assessing risk, or proposing strategic action. The phrase *delegated judgment* can nevertheless conceal several distinct arrangements. A system may execute a pre-specified rule, generate options, rank alternatives, supply evidence, recommend an action, or trigger an action automatically. These arrangements differ in what has been delegated and in what remains institutionally human-governed.

Definition 24.419 (AI judgment-delegation profile). *An AI judgment-delegation profile records the epistemic or practical function assigned to the artificial system, the decisions or intermediate judgments retained by human or institutional positions, the source of governing criteria, review and override conditions, affected parties, responsibility allocation, records required for reconstruction, and the authority capable of revising the delegation.*

The profile separates task execution from authority. A model can rank cases while a public body retains legal authority. A decision can be formally human-signed while practical judgment has migrated to an automated recommendation that reviewers rarely challenge. Formal location of authority and effective location of judgment can therefore diverge.

Proposition 24.420 (Delegation–authority non-equivalence). *Delegating an epistemic or decision-support function to an AI system does not by itself transfer legal authority, political legitimacy, moral responsibility, or normative warrant to the system, while nominal retention of authority by a human institution does not establish meaningful*

retained judgment when challenge and override are practically ineffective.

This distinction is especially important for economic analysis because institutional actors can externalize labor or cognitive effort while retaining responsibility, or retain formal responsibility while losing practical capacity to supervise the delegated function. The latter creates a supervision paradox: the more an institution depends on AI for a function, the harder it can become to retain the expertise needed to evaluate that function independently.

Definition 24.421 (Delegation supervision gap). A *delegation supervision gap* exists when the practical expertise, time, evidence, access, or institutional authority available to review an AI-mediated judgment is insufficient relative to the consequence of the delegated function and the plausible ways in which that function can fail.

The gap can persist even with a nominal human-in-the-loop. Human presence is not equivalent to consequential review. GRE should therefore ask whether the reviewer can access relevant evidence, understand the decision context, disagree without excessive cost, and trigger correction.

24.17.5 Synthetic Evidence

AI-era symbolic abundance makes the evidential status of generated, simulated, reconstructed, or transformed artifacts a central limitation. Synthetic material can be legitimate and useful. Simulation can test hypotheses; generated examples can support training; reconstructed images can aid communication; transformed records can improve accessibility; synthetic data can protect privacy or explore scenarios. The danger arises when a representation enters an evidential chain without preserving the distinction between observation, simulation, illustration, reconstruction, transformation, and independently supported claim.

The earlier symbolic-abundance analysis emphasized that fluent output does not establish epistemic warrant (Bender et al. 2021). Provenance standards can help establish origin or transformation history without proving substantive truth (Coalition for Content Provenance and Authenticity 2026). Chapter 24's manifestation and representation analysis adds a further point: a synthetic artifact can become causally consequential through institutional uptake even when its descriptive standing is weak. Its performativity should therefore be analyzed separately from its evidential adequacy.

Definition 24.422 (Synthetic-evidence typing record). A *synthetic-evidence typing record* identifies an artifact as observation, measurement, simulation, generated example, reconstruction, transformation, illustration, imputation, or another declared type; records its provenance and production process; states the claim for which it is being used; and specifies the evidential bridge connecting the artifact to that claim.

The record is necessary because a plausible artifact can be epistemically valuable without being observational evidence. A simulation can support reasoning about a model's implications. It cannot by itself establish that the modeled mechanism exists in the world. A reconstructed historical image can illustrate a plausible scene without becoming an archival record of that scene.

Proposition 24.423 (Synthetic-evidence non-circularity condition). A *synthetic arti-*

fact does not independently corroborate the assumptions, model, or source material from which it was generated unless the evidential chain contains information or tests that are sufficiently independent of those generative inputs to discriminate among relevant alternatives.

This proposition is especially important where generated summaries, evaluations, or synthetic datasets are reused in later AI-assisted research. Repeated transformation can create the appearance of multiple supporting artifacts while their informational ancestry remains highly dependent. GRE should therefore preserve provenance and independence structure alongside content.

24.17.6 Accelerated Theory Production

Artificial systems can accelerate literature search, synthesis, coding, formal derivation, counterexample generation, model comparison, visualization, drafting, and production of candidate hypotheses. This can enlarge research possibility. It can also create a new imbalance between the rate at which theory-like objects are produced and the rate at which they can be verified, historically situated, empirically discriminated, or conceptually integrated.

Definition 24.424 (Theory-production verification gap). *A theory-production verification gap is a sustained difference between the rate at which candidate concepts, hypotheses, formalisms, models, explanations, or manuscripts can be produced through AI-assisted inquiry and the capacity available to verify sources, reconstruct derivations, test assumptions, compare serious rivals, inspect counterexamples, and accumulate independent evidence.*

The gap does not imply that rapid theory production is undesirable. It changes the bottleneck. Where candidate generation becomes cheap, discrimination and integration become more valuable. A research programme can accumulate many elegant constructions while increasing rather than reducing uncertainty about which constructions deserve retention.

Proposition 24.425 (Accelerated-theory warrant condition). *The epistemic standing of an AI-assisted theoretical construction depends on the warrant supplied for its premises, derivations, domain correspondence, rival discrimination, and empirical or interpretive support, not on the speed, fluency, formal sophistication, or volume with which candidate constructions can be generated.*

For GRE this condition has a direct methodological consequence. AI assistance can be especially productive for exploring formal alternatives, finding hidden assumptions, stress-testing definitions, checking notation, or generating candidate counterexamples. Yet every non-trivial formal object still requires locally defined semantics and every external claim still requires verified support. Accelerated production therefore increases the importance of provenance and versioning. Without them, it becomes difficult to reconstruct which insight originated in evidence, which was introduced as a heuristic, which arose from a model analogy, and which was later strengthened through independent research.

Definition 24.426 (AI-assisted theory provenance record). *An AI-assisted theory provenance record preserves, at a level proportionate to the claim, the source ma-*

terials, researcher judgments, AI-assisted transformations or candidate generation, subsequent verification, discarded alternatives, and evidence through which a theoretical construction acquired its present status.

The purpose is not to preserve every token or conversational step. It is to keep the intellectual and evidential dependencies of consequential claims reconstructible.

24.17.7 Attention and Orientation

AI-mediated abundance can widen access to candidate ideas while simultaneously reshaping which ideas become practically visible. Search systems, recommendation systems, conversational interfaces, generated summaries, ranking models, and automated research assistants all participate in attention allocation. The limitation is not only distraction or information overload. It concerns orientation: which questions, alternatives, literatures, examples, and causal framings enter the practical field of inquiry in the first place.

Attention is finite even when symbolic supply expands. Simon's scarcity argument therefore becomes more consequential rather than less consequential in high-output environments (Simon 1971). Ranking and classification can also become performative when visibility changes later behavior, investment, citation, or institutional recognition. Earlier work on rankings shows that public measures can reshape the organizations they evaluate rather than merely describe them (Espeland and Sauder 2007). AI-mediated orientation can generate analogous feedback where model-mediated salience influences which objects later accumulate evidence, resources, or attention.

Definition 24.427 (AI-mediated orientation profile). *An AI-mediated orientation profile records the systems and interfaces through which candidate questions, sources, options, or interpretations become visible; ranking and filtering criteria; user and institutional feedback; excluded or weakly represented alternatives; diversity of orientation pathways; and the later consequences of repeated exposure for inquiry and action.*

The profile prevents a common inference: broad access to an AI system does not imply broad practical exposure to the full possibility space. Users can have technically open access while converging on similar framings because interface defaults, ranking procedures, training distributions, organizational templates, or imitation dynamics narrow orientation.

Proposition 24.428 (Orientation-diversity condition). *AI-mediated inquiry preserves a wider practical orientation space when consequential positions retain access to plural sources, alternative framings, contestable ranking pathways, independent search or observation, and institutional opportunities to introduce questions or evidence not privileged by the dominant interface.*

This proposition does not imply that maximal diversity is always efficient or epistemically superior. Orientation requires selection. The limit arises when the selection architecture becomes difficult to observe or contest while its outputs are treated as neutral representations of relevance. GRE should therefore analyze attention and orientation as allocative and generative processes, not merely as user preferences.

24.17.8 Institutional Dependence

The final limitation concerns the institutional embedding of artificial capability. An organization can become dependent on a model provider, cloud infrastructure, specialized chips, retrieval service, data pipeline, identity system, proprietary interface, or externally maintained workflow. Dependence can arise even when individual components are technically substitutable because records, skills, contracts, organizational routines, compliance procedures, or user expectations have adapted around the incumbent stack.

Definition 24.429 (Institutional AI dependence stack). *An AI institutional-dependence stack records the technical, infrastructural, contractual, legal, human-skill, organizational, and archival dependencies required for an institution to continue an AI-mediated function at the level relevant to its mandate.*

The stack makes concentration analytically layer-specific. Model plurality does not establish infrastructural plurality if several models rely on the same compute or cloud providers. Open model weights do not establish institutional independence where deployment requires scarce hardware, proprietary data, restricted interfaces, or specialized operational competence. Conversely, concentrated infrastructure does not prove domination unless the relevant control and dependence mechanisms are established under the power discipline of Section 24.13.

A second limit is institutional adaptation lag. Technical capabilities and interfaces can change more rapidly than procurement cycles, professional standards, educational curricula, audit procedures, legal rules, public budgeting, archival practices, or organizational learning. The resulting mismatch can produce two symmetrical failures: institutions can prohibit useful capabilities based on obsolete risk models, or institutionalize fragile systems before adequate verification and fallback structures exist.

Definition 24.430 (AI institutional adaptation lag). *AI institutional adaptation lag is the consequential temporal difference between changes in AI-mediated capability or deployment conditions and the capacity of relevant institutions to update rules, skills, records, verification procedures, infrastructures, participation arrangements, and accountability mechanisms.*

Adaptation lag is not always undesirable. Deliberate institutions can justifiably move more slowly than technical markets where consequences are difficult to reverse. The analytical question is whether the lag protects important values and learning, or instead leaves the institution governed by assumptions that no longer match its actual dependencies and risks.

Proposition 24.431 (Institutional-dependence vulnerability condition). *AI-mediated institutional dependence becomes more consequential when a function is economically or publicly important, the supporting stack is weakly substitutable, internal verification or reconstruction capacity is thin, exit is costly, critical records or skills are not preserved, and institutional adaptation is slow relative to material changes in the supporting systems.*

These conditions do not imply that every institution should internalize its entire AI stack. Specialization can be efficient and robust. The relevant design question concerns where fallback, portability, auditability, institutional memory, contestabil-

ity, and alternative providers or pathways are required by the consequence of the function.

Definition 24.432 (AI-era GRE validity horizon). An *AI-era GRE validity horizon* is the declared period and configuration range within which an AI-related GRE claim is expected to remain warranted absent material changes in capability boundaries, deployment architecture, dependency, verification, human skill, institutional rules, or relevant neighboring-domain findings.

Proposition 24.433 (AI-era revalidation principle). *AI-related GRE claims should be revalidated when material changes cross the assumptions encoded in their validity horizon; rapid technical change is not itself a reason for skepticism, but it is a reason to make the conditions of continued warrant explicit.*

The principle closes the section by locating the AI-era problem within the broader limitation grammar of Chapter 24. Capability asymmetry, epistemic dependence, opacity, delegated judgment, synthetic evidence, accelerated theory production, attention and orientation, and institutional dependence are not arguments that AI-related economic analysis is impossible. They identify where apparently stable economic objects can be versioned, mediated, path-dependent, and rapidly reconfigured. GRE can remain useful in such an environment if it preserves configuration detail, provenance, verification burdens, capability trajectories, domain-specific correction, and explicit revalidation triggers. The next section turns from these moving limitation conditions to a more general empirical question: how GRE can identify generativity, relational causality, value conversion, capture, option-space change, power conversion, historical effects, long-horizon outcomes, and negative evidence in observational and intervention settings.

24.18 Empirical Identification Problems

The preceding sections have identified limits in ontology, epistemic access, representation, relational reconstruction, history, formalization, value analysis, power, justice, praxis, cross-domain transfer, and rapidly changing AI-mediated environments. The role of the present section is to concentrate those limitations at the point where GRE claims meet empirical evidence. Its objective is not to prescribe one privileged causal-inference technique. GRE studies heterogeneous objects that differ in observability, manipulability, temporal depth, institutional embedding, and historical specificity. The relevant discipline is therefore broader: an empirical identification claim should state the target mechanism, the observations that bear on it, the inferential bridge between manifestation and mechanism, serious rival explanations, the conditions under which the claim is expected to hold, and the evidence that would weaken or revise it. The section applies that discipline to generativity, relational causality, value conversion, value capture, option-space change, power conversion, historical effects, long-horizon outcomes, and negative evidence.

Definition 24.434 (Empirical-identification profile). A *GRE empirical-identification profile* records the target claim, empirical anchors, observability conditions, temporal and relational boundaries, proposed mechanism, intermediate implications, serious rival explanations, contrastive or negative evidence, identification assumptions, un-

Table 24.18: Selected empirical-identification problems in GRE.

Research object	Typical identification hazard	Required empirical discipline
Generativity	Later success is attributed to an earlier configuration without distinguishing selection, persistence, co-generation, or common causes	Trace the generative mechanism, intermediate capacity formation, alternative pathways, delayed effects, and failures
Relational causality	Association among connected positions is treated as causal effect of a relation	Define the relation and estimand, model interference and endogenous relation formation, and compare serious relational alternatives
Value conversion	Covarying source and target manifestations are described as conversion	Reconstruct source, target, interface, conditions, intermediate changes, and rival mechanisms
Value capture	Concentration or unequal receipt is treated as capture	Identify a value pathway, control or appropriation mechanism, relevant alternative incidence, and affected positions
Option-space change	Realized choices are treated as the feasible set	Reconstruct effective possibilities, constraints, information, access, and credible but unrealized alternatives
Power conversion	Resource or status asymmetry is treated as power	Identify the directional mechanism through which an asymmetry becomes consequential capacity over another position's possibilities
Historical effects	Later outcomes are attributed retrospectively to one prior event or institution	Preserve temporal sequence, contemporaneous alternatives, changing categories, intermediate mechanisms, and path-specific rivals
Long-horizon outcomes	Distant consequences are attributed through an uninterrupted causal story	Track mediation, maintenance, competing inputs, attrition, regime change, and horizon-dependent uncertainty
Negative evidence	Non-observation is treated as evidence of absence	Establish trace generation, detection, coverage, preservation, and the expected manifestation under the target claim

certainty, and the strongest attribution supported by the resulting evidence.

The profile extends the empirical programme introduced in Chapter 22 while turning its identification burden into an explicit limitation architecture. An observed association can be descriptively important even when mechanism identification remains weak. A process trace can strongly support sequence and institutional mediation while leaving a counterfactual unresolved. A quasi-experimental contrast can identify an average consequence of an intervention while leaving the relational mechanism partly opaque. Historical comparison can reveal path dependence while offering few repeated observations. Mixed evidence is therefore often appropriate, but methodological plurality does not mean that all combinations of evidence support the same claim.

Table 24.18 summarizes the principal identification hazards developed in the subsections below. It is not a hierarchy of methods; it identifies the empirical work required before a descriptive pattern can be promoted to the stronger GRE mechanism named in the first column.

Definition 24.435 (Mechanism-discrimination requirement). The *mechanism-discrimination requirement* is the requirement that an empirical GRE claim identify which observations would favor the proposed mechanism over serious alternatives capable of producing materially similar manifestations.

The requirement does not imply that every inquiry must establish a unique mechanism. Some research can legitimately end with an equivalence class of plausible explanations. What should be avoided is a stronger mechanism vocabulary than the evidence discriminates. The empirical limitation is therefore often an attribution ceiling rather than a binary verdict of identification or non-identification.

24.18.1 Generativity

Generativity concerns the production of later capabilities, relations, values, institutional forms, knowledge, or options. Empirical identification is difficult because many manifestations used as evidence of generation are themselves selected outcomes. A successful organization may employ well-trained workers, but the organization may have generated those capabilities, selected people who already possessed them, benefited from complementary institutions, or merely revealed capacities that were previously difficult to observe. A policy followed by later entrepreneurial activity may have generated new possibilities, redistributed existing activity, accelerated a trend already under way, or changed the categories through which activity is recorded.

Definition 24.436 (Generativity-identification profile). A *generativity-identification profile* records the proposed source configuration, generated object or capacity, generative mechanism, enabling and maintenance conditions, temporal sequence, intermediate traces, plausible pre-existing capacities, substitution or displacement, competing sources of generation, failed or unrealized cases, and the evidence used to distinguish generation from selection, revelation, persistence, transfer, or redistribution.

Realized output should therefore not be treated as a sufficient proxy for generativity. The relevant target can include a capacity that remains unused during the observation period, a relation that becomes available only under later conditions, or an option that matters because it can be exercised even if it is not chosen. At the same time, hypothetical future generation cannot be insulated from evidence merely because it concerns unrealized possibilities. GRE needs observable implications of the proposed generative process: intermediate capability formation, changed access, persistent skill, altered institutional routines, credible later reuse, new relational pathways, or systematic differences when enabling conditions are absent.

Definition 24.437 (Generativity rival set). A *generativity rival set* contains serious mechanisms that can explain a later manifestation without the proposed generative process, including where relevant selection, revelation of prior capacity, common-cause change, persistence, redistribution, displacement, conversion, measurement

change, and generation by another source.

Failure cases are particularly valuable. If the alleged source configuration repeatedly appears without the predicted intermediate capability, or if the later capability appears under comparable conditions without the source, the generativity account requires revision. Such evidence need not refute every role of the source. It can narrow the claim from generation to contribution, enablement, acceleration, or conditional participation.

Proposition 24.438 (Generativity-identification condition). *A GRE generativity claim receives stronger empirical support when the generated object is independently typed, intermediate capacity or relation formation is evidenced where observable, serious selection and common-cause explanations are addressed, condition-sensitive or contrastive cases support the proposed pathway, and failed or delayed cases remain capable of narrowing the attribution.*

24.18.2 Relational Causality

Relational causality is more demanding than showing that outcomes are correlated among connected positions. The relevant relation can be constitutive, enabling, constraining, mediating, informational, contractual, infrastructural, symbolic, or directly causal in a narrower intervention sense. GRE therefore needs to specify what causal claim is being made about the relation and what change would count as a change in the causal object.

Definition 24.439 (Relational causal estimand). *A relational causal estimand specifies the relational feature whose consequence is being investigated, the affected positions, the counterfactual or contrastive change in that feature, the relevant boundary and horizon, interference assumptions, and the outcome or relational transformation whose difference is to be attributed.*

This definition prevents relation labels from functioning as unexplained treatments. “Trust,” “dependence,” “ownership,” “membership,” “proximity,” or “centrality” can each contain several empirically distinct relations. A study that changes communication frequency may not have changed trust. A legal reform can alter formal ownership while practical control remains stable. A platform ranking change can affect exposure without changing the underlying social relation. The intervention or variation must correspond sufficiently to the substantive relation named in the causal claim.

Relational systems also create interference. One position’s treatment can alter another position’s exposure, alternatives, expectations, or relational neighborhood. Relation formation is often endogenous: actors select partners, institutions route interaction, and prior outcomes change later ties. Standard independence assumptions can therefore erase the very structure GRE intends to study.

Definition 24.440 (Relational-causality identification burden). *The relational-causality identification burden requires explicit treatment of relation semantics, endogenous relation formation, interference, boundary dependence, temporal ordering, relevant relational alternatives, and the mechanism through which the specified relation is expected to change the target outcome or configuration.*

Proposition 24.441 (Relational causal restraint). *Network association, relational centrality, repeated interaction, or positional similarity does not by itself identify a causal effect of the named relation; causal attribution should remain bounded by the relation semantics, exposure structure, interference conditions, and contrastive evidence that the empirical design can support.*

24.18.3 Value Conversion

Section 24.11 treated value conversion as a mechanism-identification problem and introduced a conversion-identification dossier, rival set, ladder, and attribution ceiling. The empirical limitation can now be stated in the broader language of this section. Conversion is one case in which an observed before–after relation can conceal several different mechanisms. Source depletion and target gain may reflect conversion, but they may also reflect transfer to another position, common-cause change, target-side generation, reclassification, circulation, measurement substitution, or simultaneous manifestation of a third process.

Definition 24.442 (Conversion evidence nesting). *Conversion evidence nesting* is the requirement that evidence for a value-conversion claim preserve separately the source and target typing, interface exposure, condition architecture, intermediate transformation evidence, source-side change, target realization, and serious rival mechanisms rather than compressing them into one source–target association.

The nesting requirement also limits scalar conversion-rate claims. A stable empirical ratio between source and target indicators can be useful descriptively while remaining semantically weaker than a conversion rate. The latter additionally requires a defensible mapping between the value forms, control of relevant conditions, and evidence that the ratio is generated by the proposed interface rather than by changing composition or measurement.

Proposition 24.443 (Conversion identification portability limit). *Empirical support for a conversion mechanism in one institutional regime does not by itself identify the same mechanism, interface, or conversion rate in another regime where source meaning, target realization, eligibility, power, complementary conditions, or measurement architecture differ materially.*

24.18.4 Value Capture

Capture is empirically difficult because several visible patterns can resemble it. Concentrated receipt, high intermediary retention, unequal bargaining outcomes, platform fees, rent, organizational surplus, or persistent advantage can each be normatively or economically important without establishing capture in the specific GRE sense. Capture requires a pathway through which value, value-bearing conditions, or generative returns that could have remained available to other positions are redirected, retained, appropriated, or made conditionally accessible through a consequential mechanism.

Definition 24.444 (Capture-identification dossier). *A capture-identification dossier* records the value form or return at issue, the circulation or conversion pathway, claimant and affected positions, the proposed capture point, the control or appropria-

tion mechanism, the relevant alternative incidence, contractual or institutional rules, contribution and risk where material, persistence, and the evidence distinguishing capture from legitimate payment, transfer, concentration, or ordinary intermediation.

The relevant alternative is especially important. Without a plausible account of what would have occurred absent the alleged capture mechanism, the concept can become a label for any unequal distribution. Yet the alternative need not be an idealized equal distribution. It can be a historically available contractual arrangement, a feasible routing architecture, an institutional benchmark, a before–after comparison, or a comparative case that changes the capture mechanism while preserving other relevant conditions.

Definition 24.445 (Capture counterfactual range). A *capture counterfactual range* is the set of empirically serious alternative incidences of the relevant value or return under feasible changes to the alleged capture mechanism, with uncertainty about contribution, bargaining, risk, substitution, and third-party effects kept explicit.

Proposition 24.446 (Capture-identification condition). *Unequal receipt or retention supports a GRE capture claim only when evidence additionally identifies a materially consequential routing, appropriation, recognition, conversion, or control mechanism and supports a relevant alternative incidence against which the alleged capture is interpreted.*

24.18.5 Option-Space Change

Option-space change is among the most difficult GRE objects to identify because possibilities are not identical to observed choices. A person may not exercise a feasible option because it is unattractive, costly, unfamiliar, risky, normatively rejected, or unnecessary. Conversely, an observed action can occur under severe constraint and therefore reveal little about the breadth of available alternatives. Realized behavior is evidence about an option space only through an additional model of access, feasibility, knowledge, timing, and constraint.

Definition 24.447 (Effective option-space identification profile). An *effective option-space identification profile* records the focal position, candidate possibilities, material and institutional access conditions, information and recognition conditions, timing, costs, rights, relational dependencies, relevant thresholds, credible but unrealized alternatives, observed exercises or foreclosures, and uncertainty concerning possibilities that remain latent or unobserved.

Direct enumeration is sometimes possible. Eligibility rules can define an administrative set; transport infrastructure can determine reachable locations under specified time and cost constraints; technical permissions can define accessible operations. In other settings the space is partly latent. Career possibilities, political voice, social mobility, entrepreneurial opportunity, or capability under institutional change can require mixed evidence from histories, interviews, records, experiments, comparative cases, and structural constraints.

Definition 24.448 (Option-realization fallacy). The *option-realization fallacy* is the inference that the set of observed actions adequately represents the set of effectively

available possibilities without independent evidence concerning access, knowledge, feasibility, constraint, and credible non-use.

Proposition 24.449 (Option-space change condition). *A GRE claim that an intervention or historical process expands or contracts an option space is strengthened when the relevant possibilities are defined independently of realized choice, the constraints and access conditions governing them are reconstructed, changes in credible unrealized alternatives are evidenced where possible, and substitution among options is distinguished from genuine creation or foreclosure.*

24.18.6 Power Conversion

Chapter 16 treated power as a relational conversion problem: an asymmetry becomes power-relevant when a specified mechanism makes it consequential for another position's feasible action or future possibilities. Section 24.13 later showed why persistent asymmetry, capacity, control, and power should remain distinct. Empirical identification must therefore locate the conversion pathway between a difference in resources, information, timing, status, infrastructure, recognition, exit, or institutional position and a realized or credible capacity to condition others.

Definition 24.450 (Asymmetry-to-power conversion profile). *An asymmetry-to-power conversion profile records the initial asymmetry, the positions involved, the conversion mechanism, dependence or bottleneck conditions, practical alternatives, credible activation or withholding capacity, observed exercise or anticipatory response, counter-power, temporal persistence, and the evidence that distinguishes power conversion from correlation between advantage and outcome.*

Observed exercise is useful but not necessary. A credible ability to exclude, delay, withdraw, classify, reroute, or change terms can influence behavior without repeated overt intervention. Yet latent capacity should not become empirically unrestricted. Evidence can include contractual rights combined with practical enforceability, documented dependence, bottleneck structure, observed anticipatory adaptation, rule-setting authority, historical episodes of activation, or changes in behavior when the conversion pathway is weakened.

Definition 24.451 (Power-conversion rival set). *A power-conversion rival set contains serious explanations for an outcome associated with an asymmetry that do not require the proposed power mechanism, including productivity differences, voluntary specialization, shared constraint, institutional rule application without discretionary control, third-party enforcement, selection, and correlated advantage generated elsewhere.*

Proposition 24.452 (Power-conversion identification condition). *A resource, status, informational, temporal, or infrastructural asymmetry should be described as converted into economic power only when evidence identifies a directional mechanism through which the asymmetry materially conditions another position's possibilities and serious non-power explanations of the observed outcome are correspondingly limited.*

24.18.7 Historical Effects

Historical-effect identification is constrained by the conditions developed in Section 24.6. Archives are selective, categories change, temporal processes operate at different speeds, and later knowledge can make a realized path look more necessary than it appeared to contemporaries. A historical GRE claim must therefore reconstruct both the observed sequence and the contemporaneous possibility structure rather than infer causality backward from the outcome.

Definition 24.453 (Historical-effect identification dossier). A *historical-effect identification dossier* records the focal event, relation, institution, or configuration; the hypothesized effect; contemporaneous conditions and alternatives; temporal ordering; intermediate transformations; archival and category limitations; competing historical mechanisms; comparative or within-case contrasts; later reinterpretations; and the findings that would narrow the attribution.

Historical evidence can identify mechanisms strongly without experimental manipulation. Process tracing, institutional sequences, archival discontinuities, comparative histories, legal changes, natural experiments, actor records, material traces, and temporal coincidence with theoretically predicted intermediate changes can jointly constrain an account. The limitation lies not in the absence of random assignment as such, but in whether the historical reconstruction discriminates among serious mechanisms with enough precision for the claim being made.

Definition 24.454 (Retrospective causal compression). *Retrospective causal compression* occurs when a later outcome is explained by a small set of antecedents while intermediate contingencies, failed alternatives, category changes, maintenance conditions, and interacting mechanisms are removed from the causal narrative.

Proposition 24.455 (Historical attribution restraint). *The explanatory prominence of an antecedent in a retrospective narrative should not exceed the evidence that its mechanism remained consequential through the intervening sequence; where later maintenance, adaptation, substitution, or contingency materially shaped the outcome, historical attribution should preserve those mediations rather than treating temporal priority as sufficient causality.*

24.18.8 Long-Horizon Outcomes

Long-horizon identification compounds the preceding problems. The further an outcome lies from a proposed source, the more opportunities arise for maintenance, decay, substitution, adaptation, feedback, institutional change, new technologies, changing value forms, and exogenous shocks. A distant association can therefore be real and still provide weak evidence about the original mechanism.

Definition 24.456 (Long-horizon attribution chain). A *long-horizon attribution chain* records the proposed source, intermediate states and mechanisms, maintenance or regeneration conditions, competing inputs, feedback, attrition, regime changes, measurement changes, terminal outcome, and uncertainty accumulated across the temporal sequence.

This chain need not require every intermediate state to be observed directly. Some segments can be supported through structural constraints, historical records,

repeated local mechanisms, or convergent evidence. The discipline is to distinguish observed links, strongly inferred links, weakly inferred links, and genuinely open segments. A long-horizon conclusion can remain useful when it identifies a persistent contribution or risk pathway rather than claiming deterministic control of the terminal outcome.

Definition 24.457 (Attribution decay profile). An *attribution decay profile* records how uncertainty concerning a source's contribution changes across time as mediation, competing causes, adaptation, measurement change, and regime instability accumulate, together with observations that can renew or strengthen the attribution at intermediate stages.

The concept does not impose a universal mathematical decay rate. Some mechanisms strengthen through positive feedback; others remain stable because institutions reproduce them; still others disappear rapidly. The point is that evidential confidence should not remain automatically constant merely because the narrative maintains verbal continuity.

Proposition 24.458 (Long-horizon identification condition). A *strong GRE long-horizon attribution* requires more than temporal precedence and endpoint association: it should preserve material intermediate mechanisms, maintenance or regeneration conditions, competing causes, regime changes, and uncertainty, with the strength of the terminal claim bounded by the weakest consequentially relevant parts of the attribution chain.

24.18.9 Negative Evidence

Negative evidence is indispensable because the framework is intended to remain corrigible. Yet non-observation is not automatically evidence of absence. A relation can fail to appear because no trace was generated, the trace was not recorded, the dataset excludes the relevant positions, the observation window is too short, categories suppress the distinction, records were destroyed, or the manifestation relation changed. Conversely, a theory that treats every missing expected effect as an observability problem becomes empirically insulated.

Definition 24.459 (Negative-evidence observability condition). A *negative-evidence observability condition* specifies whether the target mechanism, if present at the claimed strength and under the stated conditions, would be expected to generate a detectable and preserved manifestation within the available observation regime.

This condition makes absence informative in proportion to expected detectability. If a proposed conversion mechanism predicts a documented intermediate administrative action and comprehensive records show none, the absence can weigh strongly against the mechanism. If an informal relation is rarely recorded and the archive contains only formal documents, non-observation carries little weight. The same logic applies to generativity, capture, power, option creation, and long-horizon effects.

Definition 24.460 (Negative-evidence diagnostic profile). A *negative-evidence diagnostic profile* records the predicted manifestation, trace-generation process, detection probability or qualitative detectability, coverage, preservation, observation horizon, data-quality limitations, null or contrary finding, implementation quality, and the

claim component that the negative evidence can legitimately weaken.

Negative evidence should also be distinguished from evidence of an alternative mechanism. A null estimate can show that one expected average effect is not detectable under a design without establishing why. A failed generative intervention can reflect an incorrect mechanism, absent enabling conditions, implementation failure, insufficient horizon, or measurement weakness. Diagnostics should identify which layer is implicated rather than moving directly from non-success to total theoretical rejection.

Definition 24.461 (Identification status ladder). An *identification status ladder* distinguishes, for a specified GRE claim, descriptive pattern, mechanism-compatible evidence, process-supported attribution, contrastively supported mechanism, regime-bounded identification, and broader transportable identification, with each stronger status requiring additional evidential and scope conditions rather than merely more observations of the same type.

The ladder is deliberately non-numeric. Different research objects admit different designs, and some historically important mechanisms cannot be repeatedly manipulated. Its function is to make claim strength explicit and cumulative. A project can advance by moving one mechanism from compatibility to process support, by discovering a scope boundary that turns a broad claim into a regime-bounded one, or by producing high-quality negative evidence that removes one rival explanation.

Proposition 24.462 (Empirical identification limitation principle). *GRE should treat empirical identification as a claim-relative and mechanism-discriminating process: evidence should support no stronger attribution than its observability, temporal reconstruction, relation semantics, rival-mechanism discrimination, negative evidence, and scope conditions permit, and persistent identification failure should narrow, retype, or withdraw the dependent claim rather than be absorbed into increasingly permissive relational language.*

This principle identifies both the empirical ambition and the empirical limit of GRE. The framework is useful only if its distinctive objects—generativity, conversion, capture, changing option spaces, relational power, historical trajectories, and long-horizon effects—can be connected to evidence in ways that distinguish at least some serious alternatives. It need not reduce every object to one experiment, coefficient, or dataset. It does require a research architecture in which stronger mechanism language incurs stronger identification burdens and in which negative findings can alter the theory. The next section turns to a different limitation. Even where empirical mechanisms are well identified, evidence may remain insufficient to determine one uniquely warranted normative judgment.

24.19 Normative Underdetermination

Section 24.18 established that GRE mechanism language should be no stronger than the evidence that discriminates the proposed mechanism from serious rivals. The role of the present section is to examine a different limitation that remains even after descriptive and causal identification is comparatively strong. Its objective is to specify how several serious normative evaluations can remain compatible with the

same well-reconstructed economic configuration, to identify the premises at which those evaluations diverge, and to state what GRE can and cannot conclude without importing a complete moral, legal, or political theory. The method is premise-tracing rather than normative aggregation. Empirical findings constrain the admissible description of consequences, affected positions, capacities, burdens, power, option structures, and historical transmission; normative conclusions additionally depend on judgments concerning standing, baseline, rights, priority, threshold, responsibility, aggregation, procedure, and temporal concern. Normative underdetermination therefore concerns the residual plurality of warranted evaluation after relevant empirical uncertainty has been reduced, not the absence of reasons or the impossibility of judgment.

Definition 24.463 (GRE normative-evaluation profile). A *GRE normative-evaluation profile* records the empirical object and evidential status, affected positions and standing assumptions, relevant value forms and burdens, proposed normative framework or premises, baseline, priority or aggregation rule where applicable, rights or constraints, temporal horizon, domain-specific normative authority, resulting conditional judgment, serious rival judgments, and unresolved normative remainder.

The profile generalizes the justice-specific analysis of Section 24.14. It prevents a technically rich description from silently carrying an unmarked evaluative conclusion. The same empirically identified configuration can be evaluated differently because one framework prioritizes rights, another gives greater weight to aggregate consequences, another emphasizes relational non-domination, another protects sufficiency thresholds, and another assigns special weight to historical repair or future generations. These disagreements can sometimes be narrowed by better facts, but they cannot always be eliminated by more detailed measurement of the same facts.

Definition 24.464 (Fact–norm bridge). A *fact–norm bridge* is an explicit premise or rule connecting a descriptive or causal GRE finding to a normative judgment, priority, permission, prohibition, obligation, or evaluative ranking.

Table 24.19 summarizes recurrent cases in which descriptive clarity does not itself settle evaluative authority. The table is not a catalogue of normative theories. It identifies the additional bridge that must be made visible before a GRE property is treated as a reason for action or institutional judgment.

24.19.1 Empirical Constraint on Normative Judgment

Facts do not mechanically generate normative conclusions, but normative arguments are not independent of facts. A recommendation can rely on a mistaken account of who bears a burden, whether a capability is actually accessible, whether a conversion interface is voluntary, whether an intervention preserves options, or whether a historical claim is causally connected to a present configuration. Empirical correction can therefore defeat a normative argument by undermining one of its factual premises even where the underlying normative principle remains unchanged.

Definition 24.465 (Empirical–normative chain). An *empirical–normative dependency chain* records the descriptive and causal findings used in a normative argument, the fact–norm bridges applied to them, the intermediate evaluative conclusions, the fi-

Table 24.19: Selected sources of normative underdetermination in GRE.

GRE finding	Normative ambiguity	Required evaluative discipline
Generativity	More generated capacities or possibilities can include harmful, exclusionary, or dominating consequences	Specify what is generated, for whom, with which burdens, and under which value rule
Stability	Persistence can protect valuable coordination or reproduce oppression and lock-in	Identify the object preserved, alternatives suppressed, transition costs, and normative basis for preservation
Capability	Expanded practical ability can improve agency while remaining unjustly distributed or increasing capacity to dominate	Separate capability magnitude from standing, distribution, burden, rights, and relational position
Option expansion	A larger option set can increase freedom or impose maintenance costs, harmful choices, manipulation, or decision burden	Evaluate effective accessibility, quality, distribution, reversibility, and fore-closed commitments
Efficiency or conversion success	Efficient transformation can coexist with capture, coercion, unequal standing, or residual loss	State the protected values, incidence, interface control, and non-converted remainder
Power reduction	Reduced conditioning capacity in one relation can increase vulnerability or transfer power elsewhere	Trace the affected relations, safeguards, alternatives, and normative object of the intervention
Institutional settlement	A rule, vote, market, court, or administrative process can produce practical determinacy without resolving value conflict	Distinguish procedural authorization from substantive normative resolution
Cross-domain consequence	Economic effects can be normatively relevant without establishing legal validity, political legitimacy, educational quality, ecological worth, or other domain judgments	Preserve domain-specific normative provenance and correction authority

nal judgment or recommendation, and the points at which revised evidence would change the argument.

This chain helps distinguish disagreement about evidence from disagreement about normative premises. Two researchers can share a normative commitment while disagreeing about whether the empirical conditions activating it are present. Conversely, they can agree fully on the economic reconstruction and still disagree because they assign different standing, thresholds, baselines, rights, or priorities. These are different intellectual situations and should not be collapsed into one generic category of value disagreement.

Definition 24.466 (Normative-premise sensitivity profile). A *normative-premise*

sensitivity profile identifies which normative premises are necessary for a GRE-supported judgment, which conclusions remain stable across serious alternative premises, which conclusions reverse or become indeterminate, and which empirical findings would materially change the sensitivity pattern.

Empirical enrichment can narrow underdetermination. If several normative frameworks reject domination, then stronger evidence of coercive dependency can create convergence even where the frameworks disagree elsewhere. If an alleged benefit disappears under better identification, frameworks that previously disagreed over distribution of that benefit may converge in rejecting the policy. Such convergence is analytically important, but it does not prove that one framework is universally correct.

Proposition 24.467 (Factual-refinement condition). *Better empirical identification can eliminate normative conclusions that depend on false or unsupported factual premises and can create cross-framework convergence, but it does not by itself select among serious normative frameworks whose remaining disagreement arises from distinct standing, priority, rights, baseline, aggregation, procedural, or temporal premises.*

Normative underdetermination is therefore compatible with rigorous empirical criticism. It is not a license to treat every normative position as equally supported. Some positions can be factually inconsistent, internally incoherent, incompatible with their own declared premises, or dependent on consequences that the evidence does not support. The limit concerns what remains after those defects have been addressed.

24.19.2 Normative Status of Generativity

Generativity is one of GRE's most distinctive descriptive objects, but it is not an independent source of moral authority. Section 24.9 distinguished generative attribution from generative value. The present subsection states the broader normative implication. A process can generate capabilities, institutions, knowledge, relations, identities, options, or future conversion pathways while also generating domination, ecological burden, exclusion, dependency, fragility, or destructive capacity. Conversely, restraint, preservation, refusal, or closure can be normatively justified where further generation would damage protected values or relations.

Definition 24.468 (Generativity–goodness bridge profile). *A generativity–goodness bridge profile* records the generated or preserved objects, affected positions, positive and negative downstream consequences, foreclosed alternatives, distribution of generative capacity, relevant protected values, normative premise connecting generation to evaluation, and the horizon over which the judgment is made.

The profile prevents a common teleological slide. A historically generative institution is not therefore good because it produced many later developments, and an institution that slows transformation is not therefore bad because it reduces novelty. Historical influence and normative merit are different claims. The same distinction applies to innovation policy, education, research, infrastructure, artificial intelligence, finance, and organizational design.

Definition 24.469 (Generative-direction remainder). A *generative-direction remainder* consists of normatively relevant consequences concerning the kind, distribution, accessibility, reversibility, burden, or foreclosure of generation that are not represented by a claim that a system is more or less generative.

Generativity can nevertheless be normatively relevant. A framework that values agency can treat capability generation as one reason in favor of a configuration; a framework concerned with future generations can value preservation of regenerative capacity; a framework concerned with domination can object to generativity concentrated in one position's ability to shape others. The same generative fact can therefore enter different normative arguments without possessing one built-in evaluative sign.

Proposition 24.470 (Generativity normative non-sufficiency). *Evidence that a configuration is more generative does not by itself establish that it is normatively superior; the evaluative conclusion depends on what is generated or foreclosed, for whom, through which relations, with which burdens and power effects, under which temporal horizon, and according to which independently stated normative premises.*

24.19.3 Normative Status of Stability

Stability has a similar ambiguity. Persistent institutions can support trust, coordination, identity, long-horizon investment, care, rights protection, ecological stewardship, or predictable conversion rules. The same persistence can reproduce domination, exclusion, obsolete categories, locked-in infrastructure, unequal property relations, or harmful dependency. Instability can destroy valuable relations, yet destabilization can also be necessary for reform.

Definition 24.471 (Stability-evaluation profile). A *stability-evaluation profile* records the object and mechanism of persistence, beneficiaries and burdened positions, protected functions, reproduced harms, adaptation capacity, exit and revision conditions, suppressed alternatives, transition costs, and the normative premise under which preservation or destabilization is evaluated.

This profile applies equally to resilience. A system can be resilient because it regenerates valuable coordination after disturbance, or because power holders possess sufficient resources to reproduce an unjust arrangement. Resilience is therefore relationally and normatively typed. The same is true of equilibrium, near-criticality, robustness, and institutional continuity. None receives a positive normative sign merely from dynamical persistence.

Definition 24.472 (Preservation–change tension). A *preservation–transformation tension* exists when preserving a valued relation, institution, capability, or coordination structure materially conflicts with changing another normatively salient burden, exclusion, relation, or power structure.

Such tensions can be genuine rather than artifacts of poor modeling. A welfare institution can require continuity while its eligibility categories require reform. A community can value relational continuity while younger members seek broader options. An ecological regime can require long-horizon stability while livelihoods need near-term transformation. GRE can reconstruct these couplings and transition bur-

dens; the relative normative priority among them requires additional premises.

Proposition 24.473 (Stability normative non-sufficiency). *Persistence, resilience, robustness, equilibrium, or successful reproduction of a relational configuration does not by itself establish its goodness, legitimacy, or justice; normative evaluation requires specification of what is being preserved, which alternatives are constrained, who bears the costs of continuity or change, and why preservation has evaluative priority in the stated context.*

24.19.4 Capacity Expansion in Justice Evaluation

Capability and capacity language can appear normatively attractive because expanded practical ability often supports agency, participation, learning, resilience, or future possibility. Yet an increase in capacity is not equivalent to an increase in justice. Capacity can be distributed unequally, generated through exploitation, exercised to dominate others, or accompanied by burdens that fall on positions whose own capacity contracts. Some capacities can also be normatively restricted because their exercise violates rights or threatens protected ecological, relational, or institutional conditions.

Definition 24.474 (Capacity-justice bridge). *A capacity-justice bridge specifies which capacity is normatively relevant, whose capacity counts and with what standing, how the capacity was generated, its effective accessibility and durability, burdens and externalities, distribution across positions, interaction with rights and dependence, and the normative principle connecting capacity to a justice judgment.*

The distinction is important for economic development, education, AI access, health, financial inclusion, public infrastructure, and organizational capability. A programme can increase average capability while deepening dependence on an infrastructure controlled by a narrow set of actors. Another can distribute resources equally while producing unequal capability because positions face different conversion conditions. GRE can identify these mechanisms without treating one empirical capability measure as a complete justice criterion.

Definition 24.475 (Capacity asymmetry remainder). *A capacity asymmetry remainder consists of normatively relevant differences in standing, burden, dependence, control, rights, vulnerability, historical position, or conversion conditions that remain after the magnitude of the focal capacities has been compared.*

Capacity also interacts with responsibility. Greater capacity can create stronger expectations of contribution under some normative frameworks, while other frameworks resist deriving obligations merely from ability. GRE can show who can act, who controls enabling resources, and who is positioned to repair harm. The transition from ability to duty is a separate normative bridge.

Proposition 24.476 (Capacity non-derivation condition). *An observed increase, equality, or asymmetry of capacity does not uniquely determine justice, entitlement, responsibility, or obligation; such conclusions require independent premises concerning standing, rights, burden, historical responsibility, conversion conditions, and the legitimate relation between ability and duty.*

24.19.5 Normative Evaluation of Option Expansion

GRE repeatedly treats option spaces as economically important because institutions, resources, relations, knowledge, and power can expand or contract what positions can credibly do. Option expansion is nevertheless normatively ambiguous. A larger formal choice set can contain inaccessible options, harmful options, manipulative choices, high-maintenance options, or possibilities that impose decision burdens. Valuable commitments can also reduce some future options deliberately: contracts, caregiving relationships, constitutional rules, professional obligations, ecological protection, and long-term public investment can each close possibilities in order to preserve other goods.

Definition 24.477 (Option-expansion value profile). An *option-expansion value profile* records the options added or removed, effective accessibility, quality and consequence of the options, distribution across positions, information requirements, maintenance cost, decision burden, manipulation or coercion risk, reversibility, protected commitments, and the normative premise connecting optionality to value.

The profile separates formal multiplicity from effective freedom. Ten nominal options can provide less practical agency than three credible options if the former are inaccessible, poorly understood, strategically structured, or dependent on relations outside the chooser's control. Conversely, a temporarily inaccessible option can remain valuable where preserving it protects future autonomy under improved information.

Definition 24.478 (Option-quality remainder). An *option-quality remainder* comprises normatively relevant properties of an option set that are not captured by its cardinality or nominal expansion, including accessibility, safety, information, reversibility, dignity, dependency, maintenance burden, and effects on other positions.

Option contraction can therefore be either harmful foreclosure or justified constraint. Regulation can remove exploitative options; environmental protection can close profitable but destructive uses; professional standards can remove unsafe practices; an individual commitment can voluntarily narrow later choice. GRE can reconstruct who closes which options, through what authority, and with which consequences. Whether the closure is justified depends on the accompanying normative argument.

Proposition 24.479 (Optionality normative non-monotonicity). *Normative value need not increase monotonically with the number of available options; the evaluative significance of option expansion depends on effective accessibility, option quality, distribution, burdens, effects on others, protected commitments, and the normative reasons for preserving or constraining the relevant possibility space.*

24.19.6 Plural Normative Framework Comparison

Normative underdetermination becomes clearest when several serious frameworks are applied to the same empirically reconstructed configuration. A rights-oriented analysis can object to an intervention that produces large aggregate gains by violating protected claims. A prioritarian or sufficientarian analysis can evaluate the same distribution differently from an equalizing rule. A relational analysis can focus on

domination or dependence that an outcome metric omits. A historical-repair framework can assign weight to past wrongs that a forward-looking framework treats differently. These examples do not imply that all frameworks are equally coherent or appropriate. They show that empirical completeness does not eliminate the need to state which normative architecture is doing the evaluative work.

Definition 24.480 (Normative-framework comparison dossier). A *normative-framework comparison dossier* records the common empirical reconstruction, each serious framework's standing rules, baselines, protected claims, thresholds, priorities, aggregation or non-aggregation rules, temporal treatment, procedural authority, conditional judgment, and the loci at which conclusions converge or diverge.

Comparison can improve normative analysis even when it does not yield a single ranking. Some conclusions can be robust across frameworks. A policy can remain objectionable because it fails its stated objective, imposes severe uncompensated burdens, or creates concentrated domination under several different evaluative architectures. Other conclusions can remain framework-sensitive. The appropriate output can therefore be a conditional map rather than a forced meta-ranking.

Definition 24.481 (Cross-framework convergence set). A *cross-framework convergence set* contains the judgments, constraints, or priorities supported by several serious normative frameworks despite differences in their deeper premises, together with the empirical conditions on which that convergence depends.

Definition 24.482 (Cross-framework divergence set). A *cross-framework divergence set* contains materially different judgments that remain after the frameworks have been applied to the same relevant empirical reconstruction, with the responsible normative divergence loci identified explicitly.

Neither set establishes ultimate normative truth. Convergence can arise from shared but contestable premises; divergence can reflect genuine pluralism or unresolved argument rather than permanent incomparability. The analytical gain lies in locating the disagreement instead of allowing it to hide inside technical choices such as discount rates, welfare weights, thresholds, eligibility rules, or optimization objectives.

Proposition 24.483 (Conditional normative determinacy). *GRE can support determinate normative conclusions conditional on explicit normative premises and can identify conclusions robust across several serious frameworks, but cross-framework convergence should not be treated as proof of universal validity and persistent divergence should not be concealed by an unmarked aggregate objective.*

24.19.7 Domain-Specific Normative Authority

Normative premises are also domain-sensitive. Economic consequences can matter greatly to legal, political, educational, ecological, medical, technological, or aesthetic judgments without exhausting the normative objects of those domains. A policy that increases economic capability does not thereby become legally valid. A technically effective AI deployment does not thereby become institutionally legitimate. A profitable ecological intervention does not establish ecological acceptability. A learning technology that raises measured productivity does not establish educational quality.

The domain-transfer discipline of Section 24.16 therefore applies to normative authority as well as descriptive concepts.

Definition 24.484 (Domain-normative provenance profile). A *domain-normative provenance profile* records the normative claim, the domain whose objects and standards it concerns, the economic findings GRE contributes, the external normative premises or authorities required, translation or conflict across domains, the correction source, and the GRE conclusions that would change if the domain-specific normative judgment were revised.

The profile does not require disciplinary isolation. Economic analysis can reveal hidden burdens that materially alter a legal or political judgment; ecological analysis can change what an economic intervention counts as feasible; educational theory can revise the meaning of capability generation; political theory can challenge whether a procedurally efficient arrangement is legitimate. The point is reciprocal correction without silent annexation.

Definition 24.485 (Normative-authority transfer limit). A *normative-authority transfer limit* is reached when a GRE property or economic criterion is used to settle a domain-specific normative judgment whose validity depends on standards, standing relations, or justificatory premises not established by the economic analysis itself.

Domain-specific normativity can also feed back into GRE. If law determines that a nominally transferable entitlement is non-transferable, if ecology establishes a protected threshold, or if educational theory rejects a performance proxy as an adequate educational objective, the economic analysis should update its feasible set, conversion architecture, value representation, or scope. Such correction does not subordinate economics generally to another domain; it recognizes claim-specific provenance.

Proposition 24.486 (Domain-specific normative deference). *Where a GRE conclusion depends materially on a legal, political, ecological, educational, technological, or other domain-specific normative judgment, GRE should preserve the external provenance and revisability of that judgment rather than treating economic consequence, efficiency, generativity, or practical settlement as independent normative authority over the receiving domain.*

24.19.8 Scope of GRE Normative Claims

Normative underdetermination does not require GRE to be normatively silent. Economic analysis can reveal hidden incidence, dependency, interface control, generated or foreclosed possibilities, and delayed or residual burdens; such findings can defeat normative arguments that rely on inaccurate descriptions. GRE can also reason conditionally from explicit principles and identify judgments robust across several serious frameworks.

Definition 24.487 (GRE normative-claim ladder). The *GRE normative-claim ladder* distinguishes: normatively relevant empirical description; framework-relative conditional evaluation; cross-framework convergence; explicitly justified substantive normative commitment; and current normative non-claim. Movement to a stronger level requires additional normative warrant rather than additional economic detail alone.

The fourth level is possible only through additional argument. A research pro-

gramme can explicitly defend a right, threshold, standing rule, democratic principle, ecological constraint, or other commitment and then examine its economic realization. The commitment should not be presented as if it followed analytically from relation, generation, efficiency, stability, capacity, or option structure itself.

Definition 24.488 (GRE normative-claim ceiling). A *GRE normative-claim ceiling* is the strongest normative conclusion supported by the combination of empirically warranted economic findings, explicitly stated normative premises, domain-specific authority, cross-framework robustness where relevant, and acknowledged unresolved remainder in a scoped inquiry.

This ceiling remains compatible with practical responsibility. Institutions may need to act while disagreement persists. The participatory, reversible, monitored, repairable, and reopenable architecture of Section 24.15 can support conditional settlement without redescribing it as final normative resolution.

Definition 24.489 (Normative openness without neutrality). *Normative openness without neutrality* is the stance in which GRE rejects self-validating moral interpretations of its descriptive properties while permitting factual criticism, conditional evaluation, cross-framework comparison, disclosure of power and burden, and independently justified substantive commitments.

The stance avoids normative overreach, where technical vocabulary hides a contestable priority, and false neutrality, where existing institutions, metrics, market outcomes, or administrative settlements are treated as normatively unproblematic because no premise is stated. Silence can itself preserve an inherited normative architecture.

Proposition 24.490 (Normative-underdetermination principle). *Even when a GRE empirical structure is strongly identified, no uniquely authoritative normative ordering should be claimed beyond explicit premises, domain-specific standards, and defensible fact–norm bridges; unresolved divergence should not be converted into apparent determinacy by generativity, stability, capability, optionality, efficiency, or aggregation alone.*

Normative underdetermination is therefore a boundary on derivation, not on inquiry. GRE can expose consequences, dependencies, conversion, capture, circulation, power, option structure, historical transmission, and residual value; it can also distinguish empirical disagreement from persistent normative divergence and identify conditional or cross-framework conclusions. It cannot, without additional argument, convert those descriptive resources into a complete moral ordering. The next section turns to the recurrent failure modes through which GRE could exceed its relational, generative, formal, historical, normative, methodological, disciplinary, or conceptual warrant.

24.20 Failure Modes of GRE

The preceding sections have identified ontological, epistemic, representational, relational, historical, formal, value-theoretical, power-theoretical, normative, practical, cross-domain, AI-era, and empirical-identification limits. The role of the present section is to convert that dispersed limitation architecture into a diagnostic taxonomy

of characteristic ways in which Generative Relational Economics can exceed its own warrant. A failure mode is not yet identical to evidence that GRE is false. It is a recurrent pattern of reasoning, modelling, interpretation, or transfer through which a GRE analysis can become weaker than its vocabulary suggests. The objective is therefore operational: to distinguish local misuse from recurrent programme-level weakness, identify observable symptoms, specify proportionate corrections, and state when repeated local repair should instead escalate into the stronger question developed in the next section: what would count against GRE itself.

Definition 24.491 (GRE failure-mode profile). A *GRE failure-mode profile* records the analytical move at risk, the claim whose warrant is exceeded, the evidence or bridge that is missing, observable symptoms of the failure, serious rival interpretations, the smallest adequate correction, the expected domain of recurrence, and the conditions under which repeated recurrence should trigger revision of the framework rather than only correction of one application.

Failure modes matter because a flexible relational vocabulary can absorb anomalies too easily if every difficulty is redescribed as another relation, another layer of generativity, another hidden field, another manifestation problem, or another domain-specific exception. Such flexibility can be productive when it preserves genuinely distinct mechanisms. It becomes a liability when it protects the framework from discrimination. The diagnostic task is therefore not to make GRE inflexible, but to ensure that flexibility remains answerable to differences in mechanism, evidence, semantics, history, and normative authority.

Table 24.20 summarizes the eight failure families developed below. They can co-exist within one analysis. A historical account can simultaneously exhibit relational, generative, formal, and normative overreach; a cross-domain AI study can combine domain overreach with conceptual inflation and methodological mismatch. The taxonomy is therefore diagnostic rather than mutually exclusive.

Definition 24.492 (Failure-mode severity profile). A *failure-mode severity profile* distinguishes at least three levels: a local application defect that can be corrected without changing the relevant GRE concept; a recurrent programme-level weakness indicating that the concept, method, or bridge is systematically underspecified; and a framework-level challenge in which the recurrent failure persists despite explicit correction and therefore bears on the adequacy of the GRE architecture itself.

The distinction prevents two opposite mistakes. One is to interpret every poor application as evidence against GRE. The other is to classify every counterexample as user error. Repeated inability to apply a concept without semantic stretching is itself evidence about the concept. Repeated need for unobserved mechanisms or ad hoc domain exceptions is likewise relevant to the research programme, even if no single case is decisive.

24.20.1 Relational Overreach

Relational overreach occurs when the fact that economic phenomena are embedded in relations is allowed to substitute for a discriminating relational explanation. Nearly any social, institutional, material, ecological, or technical phenomenon can be described as relational at a sufficiently general level. The analytical question is

Table 24.20: Characteristic failure modes of GRE and their primary corrective discipline.

Failure mode	Characteristic symptom	Primary corrective discipline
Relational overreach	An observed context, association, dependence, or co-occurrence is relabeled as a relation without specifying type, direction, persistence, mechanism, or explanatory gain	Define the relation and its rivals; test boundary and scale sensitivity; preserve non-relational explanatory remainder
Generativity overreach	Persistence, transfer, selection, revelation, conversion, or later success is described as generation	Type the generated object, trace the generative mechanism, and compare rival processes and failure cases
Formal overreach	Mathematical precision, elegance, or structural resemblance exceeds the warranted semantics, identification, or empirical correspondence	State the formal role, bridge assumptions, closure, parameter status, and evidential ceiling; simplify when added structure does not discriminate
Historical overreach	Present categories, realized outcomes, or one salient antecedent are projected backward or transported across periods without adequate historical reconstruction	Reconstruct contemporaneous categories, alternatives, timescales, mediation, archival limits, and transportability conditions
Normative overreach	Generativity, stability, efficiency, capability, optionality, participation, or settlement is treated as self-validating normative authority	State the independent normative premise, standing rule, baseline, threshold, domain authority, and unresolved divergence
Methodological overreach	A preferred method determines the question, evidential standard, or admissible object rather than being selected for the local inferential task	Match method to object and claim; preserve triangulation, rival methods, and explicit method-specific blind spots
Domain overreach	GRE vocabulary or economic consequence is used to settle legal, political, ecological, educational, technological, historical, or aesthetic claims outside economic warrant	Preserve translation loss, receiving-domain semantics, external warrant, and claim-specific correction authority
Conceptual inflation	Core terms expand until nearly every phenomenon can be described as relation, value, power, field, generativity, spacetime, conversion, or circulation	Re-establish exclusion conditions, distinguish neighboring concepts, and narrow, retype, decompose, or retire concepts that lose discrimination

not whether relations exist, but whether a specified relation contributes explanatory discrimination beyond a looser description of context, correlation, co-membership,

or mutual influence.

Definition 24.493 (Relational explanatory substitution). *Relational explanatory substitution* occurs when naming a phenomenon as relational replaces, rather than advances, the specification of the relevant relation type, direction, mechanism, persistence, boundary, scale, and consequences.

A common symptom is semantic upgrading. Repeated interaction becomes trust; centrality becomes power; institutional co-membership becomes dependence; spatial proximity becomes a field relation; synchronized change becomes coupling. Such upgrades can be correct, but each requires an inferential bridge. The problem is not relational vocabulary itself. The problem is the disappearance of the evidential work needed to move from a weak relation to a stronger one.

Definition 24.494 (Relational saturation condition). A *relational saturation condition* is reached when the operative meaning of relation has expanded so broadly that serious rival accounts cannot be excluded because material properties, legal rules, institutional positions, technical constraints, intrinsic characteristics, and ordinary co-occurrence are all redescribed as instances of the same relational explanatory category.

Relational saturation weakens rather than strengthens GRE. It removes the possibility that a non-relational or mixed explanation might outperform a relational one. Section 24.5 therefore matters diagnostically: boundary, scale, identification, persistence, field, higher-order, and missingness checks are not optional refinements after a relational conclusion has already been reached. They are part of determining whether the relational conclusion is warranted.

Proposition 24.495 (Relational-overreach correction condition). *When a GRE explanation gains little discriminatory power from its relational specification, the appropriate correction is to narrow the relation, compare serious alternative mechanisms, or adopt a mixed explanatory architecture; semantic expansion of relation should not be used to make every alternative mechanism relational by definition.*

Repeated relational saturation across substantively different domains would be more serious than one local misclassification. It would indicate that relationality functions primarily as a redescriptive language rather than an explanatory constraint, and should therefore enter the counterevidence analysis developed in the next section.

24.20.2 Generativity Overreach

Generativity is central to GRE because the framework studies how economic configurations produce later capabilities, relations, values, institutions, and possibilities. Its importance creates a corresponding failure risk: processes can be described as generative simply because something valuable, persistent, or novel appears later. Section 24.18 already showed why empirical generativity requires mechanism discrimination. The present concern is broader: generativity can become an interpretive default that absorbs selection, revelation, transfer, conversion, persistence, redistribution, and adaptation.

Definition 24.496 (Generative attribution inflation). *Generative attribution inflation*

occurs when the vocabulary of generation is applied to a later difference without adequate discrimination between genuine production of a new capacity, relation, value form, institution, or option and rival processes such as selection, revelation, persistence, transfer, conversion, redistribution, or measurement change.

The risk is amplified by positive connotations. In ordinary language, generation can suggest creativity, growth, or improvement. GRE explicitly rejects that implication: harmful dependence, exclusionary institutions, ecological degradation, surveillance capacity, or domination can also be generated. Yet even this broader use can become too permissive if every causal consequence is described as generative.

Definition 24.497 (Generative specificity test). A *generative specificity test* asks whether the analysis independently identifies what is generated, what did not previously exist in the relevant sense, which mechanism produces it, which conditions enable or maintain it, which rival processes can produce similar manifestations, and what evidence would reduce the claim from generation to contribution, transfer, persistence, conversion, or association.

A further failure mode is generative chaining without evidence. One relation is said to generate a capacity, which generates value, which generates institutions, which generates later option spaces. Long generative chains can be theoretically plausible while empirical support is strong only for the endpoints. The chain should therefore preserve link-specific warrant and uncertainty rather than inheriting confidence automatically from the surrounding theory.

Proposition 24.498 (Generativity-overreach restraint). *GRE should reserve generative language for claims that identify a typed generated object and a supported production mechanism; where the evidence supports only persistence, transfer, enablement, conversion, association, or contribution, the weaker description is analytically preferable to preserving generative vocabulary by semantic broadening.*

24.20.3 Formal Overreach

Formal overreach arises when the precision of a representation is mistaken for precision in the represented object. Section 24.7 distinguished schematic, structural, analogical, and empirically parameterized formalisms. The failure mode appears when these epistemic statuses blur: a useful diagram is read as a causal model, an elegant structural analogy acquires ontological authority, a parameter receives an empirical interpretation it cannot support, or a mathematically closed system is treated as substantively closed.

Definition 24.499 (Formal-warrant mismatch). A *formal-warrant mismatch* occurs when the inferential strength attributed to a mathematical object, parameter, structure, or result exceeds the independently justified semantics, closure conditions, empirical identification, or correspondence between the formal system and the GRE object being represented.

Formal overreach can be subtle because the resulting model may be internally impeccable. A theorem can be correct under assumptions that are poorly matched to the empirical system. A complex-valued history representation can be mathematically coherent while the meaning of its phase remains unspecified. A 2-complex can

preserve some historical structure while omitting institutional semantics that drive the economic outcome. Internal formal validity and external analytical adequacy are therefore distinct.

Definition 24.500 (Elegance-substitution failure). An *elegance-substitution failure* occurs when simplicity, symmetry, unification, mathematical richness, or formal tractability functions as a substitute for independent evidence that the representation preserves the mechanisms or distinctions required by the substantive claim.

The correction is not anti-formal. Strong formalization can reveal hidden assumptions, derive consequences, expose inconsistency, and organize complex relational structure. The correction is to keep an explicit bridge between formal objects and the empirical or conceptual distinctions they represent, together with an account of what the formalism omits.

Proposition 24.501 (Formal-downscaling principle). *When additional formal structure does not add empirically or conceptually discriminating consequences, GRE should lower the evidential status of the formal claim or simplify the representation rather than treating mathematical richness as independent support for the represented mechanism.*

24.20.4 Historical Overreach

Historical overreach occurs when GRE's historical sensitivity becomes rhetorical rather than reconstructive. A theory can mention path dependence, context, history, or multiple timescales while still projecting current categories backward, compressing intermediate contingencies, treating surviving institutions as inevitable, or transporting a mechanism across periods without checking whether its constitutive conditions remained stable.

Definition 24.502 (Historical-scope leakage). *Historical-scope leakage* occurs when a claim warranted for one historical configuration, category regime, temporal scale, or institutional period is extended to another without an explicit bridge establishing which objects, mechanisms, and meanings remain sufficiently comparable.

Historical overreach can also enter through causal narratives. Once an outcome is known, earlier institutions can appear to have been oriented toward producing it. GRE's generative vocabulary can unintentionally intensify this risk by encouraging narratives in which earlier relations are reconstructed mainly in terms of what they later generated. Section 24.6 therefore requires contemporaneous possibility structures, failed alternatives, archival limits, and category genealogies.

Definition 24.503 (Generative hindsight bias). *Generative hindsight bias* is the retrospective interpretation of an earlier relation, institution, or event primarily through the later objects it helped produce, in a manner that understates unrealized alternatives, contemporaneous uncertainty, later maintenance, substitution, and intervening causes.

Historical generalization can remain legitimate. A mechanism can recur across periods, and historical comparison can reveal robust constraints or patterns. The failure mode lies in treating recurrence of labels, institutions, or outcomes as evidence that the same mechanism persisted unchanged.

Proposition 24.504 (Historical-overreach correction condition). *A GRE historical*

claim should be narrowed, retyped, or periodized when its explanatory mechanism depends materially on categories, institutional conditions, timescale separations, or possibility structures that are not stable across the periods being compared.

24.20.5 Normative Overreach

Normative overreach occurs when a descriptive GRE property is allowed to function as an unstated evaluative standard. The most recurrent risks are now familiar: generativity becomes goodness, stability becomes desirability, option expansion becomes welfare, participation becomes legitimacy, economic capability becomes justice, compensation becomes repair, and practical settlement becomes normative resolution. Section 24.19 showed why each inference requires additional normative premises.

Definition 24.505 (Normative-premise concealment). *Normative-premise concealment* occurs when a substantive priority, standing rule, baseline, threshold, aggregation rule, right, or procedural commitment is embedded in GRE terminology, metrics, or decision criteria without being identified as an independent normative premise.

The failure mode can appear in formally neutral language. A model that optimizes generative capacity can privilege particular kinds of capacity; an option-space metric can treat more options as better; a resilience measure can privilege persistence; a conversion-efficiency criterion can ignore residual value; a participation score can count presence rather than consequential voice. The normative choice has not disappeared. It has moved into the representation.

Definition 24.506 (Settlement-as-justice failure). A *settlement-as-justice failure* occurs when an institutional outcome, market exchange, negotiated agreement, vote, legal resolution, administrative procedure, or operational compromise is treated as establishing justice merely because it settles action or coordinates expectations.

False neutrality is the mirror image. GRE can overreach normatively by making hidden judgments, but it can also fail by refusing to identify the normative assumptions already built into institutions, property arrangements, metrics, or policy baselines. Normative openness therefore requires explicitness rather than silence.

Proposition 24.507 (Normative-overreach correction condition). *Where a GRE conclusion depends on a claim about goodness, justice, legitimacy, acceptable burden, standing, or priority, the independent normative bridge and its domain-specific authority should be stated; if that bridge remains contested, the economic analysis should preserve conditional or plural normative conclusions rather than convert institutional settlement or descriptive advantage into final normative authority.*

24.20.6 Methodological Overreach

GRE is methodologically plural, but pluralism can itself fail in two ways. A preferred method can dominate because it fits the theorist's training or the framework's vocabulary rather than the research object. Alternatively, multiple methods can be displayed ceremonially without being allowed to challenge one another. The relevant standard is not methodological variety but inferential fit.

Definition 24.508 (Method-object mismatch). A *method-object mismatch* occurs when a method's observability assumptions, unit of analysis, temporal resolution,

manipulability requirements, representational categories, or inferential strengths are poorly aligned with the GRE object or claim for which the method is used.

Examples include estimating a stable scalar parameter for a rapidly changing institution; inferring latent relations solely from cross-sectional indicators; using narrative evidence to support a precise quantitative effect without an adequate bridge; using network topology to infer relation semantics; or using a formal model to replace rather than organize empirical inquiry. None of these method families is intrinsically inappropriate. The mismatch is claim-specific.

Definition 24.509 (Methodological confirmation asymmetry). *Methodological confirmation asymmetry* occurs when evidence generated by one method is accepted readily when it supports a GRE claim but dismissed as method-limited when it challenges the claim, without a symmetric standard established in advance.

This asymmetry is especially dangerous in a plural programme because conflicting findings can always be attributed to the limitations of the inconvenient method. Genuine pluralism requires pre-specified or at least transparently reconstructed reasons for weighting different evidence and explicit treatment of disagreement among methods.

Proposition 24.510 (Methodological-overreach correction condition). *Method selection in GRE should be governed by the local inferential task, and disagreement among credible methods should be treated as evidence about the object, assumptions, scale, or observability unless an independently justified reason establishes why one method is inapplicable.*

24.20.7 Domain Overreach

Domain overreach occurs when the portability architecture of Chapter 23 is bypassed. GRE concepts can illuminate neighboring domains, but economic incidence does not confer legal, political, ecological, educational, historical, technical, social, or aesthetic authority. A concept can travel successfully while changing its meaning, and an economically consequential relation can remain principally constituted by another domain.

Definition 24.511 (Domain-annexation failure). A *domain-annexation failure* occurs when GRE treats a neighboring-domain object, predicate, validity condition, or normative judgment as if its economic consequences or relational representation were sufficient to reconstruct the object exhaustively within GRE.

Domain annexation can occur outward or inward. Outwardly, GRE can redescribe education as capability production, law as incentive structure, ecology as resource constraint, politics as power conversion, or AI as economic agency while suppressing receiving-domain distinctions. Inwardly, GRE can import a legal, ecological, political, educational, or technical premise and then forget that the premise remains externally warranted and revisable.

Definition 24.512 (Correction-authority bypass). A *correction-authority bypass* occurs when a GRE claim materially depends on a neighboring-domain premise but the analysis no longer records the source domain's authority to revise, reject, or retype that premise and the GRE conclusions that depend upon it.

The failure is not interdisciplinarity. It is one-directional interdisciplinarity in which GRE can borrow or export but cannot be corrected. Sections 24.16 and Chapter 23 established the opposite principle: domain interfaces should be reciprocal and provenance-preserving.

Proposition 24.513 (Domain-overreach correction condition). *When a GRE claim depends materially on a neighboring domain's object, validity standard, empirical premise, or normative judgment, the receiving or source domain should retain claim-specific correction authority, and translation success should not be interpreted as evidence that the economic representation exhausts the domain object.*

24.20.8 Conceptual Inflation

Conceptual inflation can protect the preceding failure modes. Terms such as relation, field, generativity, value, conversion, circulation, power, spacetime, participation, and manifestation can acquire ever wider extensions until coverage increases while discrimination falls.

Definition 24.514 (Conceptual inflation). *Conceptual inflation* is expansion of a GRE concept such that increasingly heterogeneous phenomena fall within it while its exclusion conditions, rival classifications, or discriminating implications weaken.

Conceptual change is not itself inflationary. The diagnostic issue is whether an extension adds a principled subtype or mechanism, or mainly protects the concept from counterexample. Broad concepts can remain useful when their internal typing is strong; the failure is semantic elasticity without corresponding analytical gain.

Definition 24.515 (Discriminatory depletion). *Discriminatory depletion* occurs when a concept can classify many cases but no longer yields sufficiently specific contrasts, exclusions, reconstruction requirements, or revision conditions to distinguish its use from serious alternatives.

Repair can involve narrowing, retyping, decomposition, regionalization, or retirement. An open research programme should not require inherited GRE vocabulary to survive merely because later claims have been stated through it.

Definition 24.516 (Concept-retirement condition). A *concept-retirement condition* is reached when repeated specification leaves a concept either too broad to discriminate among serious alternatives or so narrow that an established concept performs the same work more clearly and with fewer auxiliary assumptions.

The taxonomy therefore culminates in escalation. Local errors warrant local correction; recurrent errors warrant revision of definitions, methods, interfaces, or formalism. Persistence across applications after those repairs creates pressure on the relevant framework component.

Definition 24.517 (Failure-mode escalation record). A *failure-mode escalation record* tracks recurrence across applications, repairs already attempted, remaining auxiliary assumptions, domains in which the defect persists, and the evidence required to treat the problem as a challenge to the relevant GRE component.

Proposition 24.518 (Diagnostic escalation principle). *A recurrent GRE failure mode should not remain classified as local misuse when it persists under explicit definitions, appropriate methods, receiving-domain correction, and serious rival comparison; con-*

tinued failure after those safeguards should enter explicit counterevidence and revision analysis.

The taxonomy is therefore transitional. It identifies characteristic ways GRE can go wrong while leaving open whether a particular failure is local, recurrent, or framework-level. The next section asks the stronger question of what should count positively against GRE rather than merely invite another qualification.

24.21 Evidential Defeat Conditions in GRE

The preceding section identified recurrent ways in which Generative Relational Economics (GRE) can exceed its warrant. The present section asks a stronger question: under what conditions should evidence count positively against a GRE claim, a GRE concept, or a component of the GRE research programme? The objective is not to manufacture a single falsification rule for a heterogeneous and partly interpretive framework. It is to prevent the opposite failure, in which every adverse result is reclassified indefinitely as a local exception, a missing variable, a domain peculiarity, or a problem of application. The section therefore develops claim-specific defeat conditions for relational explanation, generative distinction, value-conversion analysis, multiscale analysis, rival explanation, domain transfer, replication, and internal consistency. The method is comparative and escalation-sensitive: counterevidence is assessed against the exact claim it bears upon, after reasonable specification and correction have been attempted, and stronger implications require recurrence across appropriately varied settings.

Definition 24.519 (GRE evidential defeat profile). *A GRE evidential defeat profile* identifies the claim under test, its declared scope, the evidence and assumptions supporting it, serious rival explanations, observations or arguments that would lower its warranted status, repairs already attempted, and the level at which unresolved counterevidence would require local withdrawal, concept revision, programme revision, or a broader challenge to GRE.

This profile separates defeat from disappointment. An intervention that performs poorly can fail for implementation reasons while leaving the underlying mechanism intact. A relational hypothesis can fail in one population because the relation is absent there while remaining well supported elsewhere. Conversely, repeated success under weak tests cannot protect a claim when stronger discriminating tests systematically favour a rival. GRE should therefore attach defeat conditions to the inferential content actually asserted rather than to the prestige or centrality of the vocabulary in which it is expressed.

Definition 24.520 (Counterevidence locality). *Counterevidence locality* is the principle that adverse evidence should initially be assigned to the narrowest GRE claim whose evidential bridge it directly undermines, while propagation to broader concepts or framework commitments requires an explicit account of shared assumptions, recurrent failure, or logical dependence.

Locality prevents one failed application from being narrated as the collapse of an entire programme. It also prevents the reverse manoeuvre in which framework-level problems are fragmented into an endless sequence of unrelated local errors. The

Table 24.21: Evidential defeat families and their primary GRE targets.

Evidence family		Primary GRE target	Stronger implication when recurrent
Relational	explanatory failure	Claimed explanatory role of a specified relation	Relational specification adds little discrimination beyond rival or mixed accounts
Generative	distinction failure	Separation of generation from transfer, selection, persistence, revelation, or conversion	Generativity category requires narrowing, retyping, or retirement in the affected domain
Conversion-analysis	failure	Typed source-interface-target mechanism	Conversion vocabulary fails to outperform simpler transmission or co-change accounts
Multiscale	failure	Claimed cross-scale bridge, aggregation, or emergence relation	Scale-transfer rules or level architecture require revision
Superior rival	explanation	Mechanism, model, or conceptual account under comparison	GRE component loses explanatory priority within the declared scope
Domain	counterexample	Portability or domain-interface claim	Transfer scope contracts; recurrent failures can defeat a purported cross-domain invariant
Empirical	non-replication	Empirical regularity or mechanism claim	Transportability, mechanism stability, or measurement architecture requires revision
Internal	inconsistency	Compatibility among GRE commitments	Core vocabulary, inference rules, or architecture requires reconciliation or abandonment

central task is to track when recurrence changes the level of the problem.

Definition 24.521 (Defeat escalation threshold). A *defeat escalation threshold* is reached when counterevidence persists across appropriately specified applications, survives reasonable repairs, recurs under methods capable of detecting the proposed mechanism, and targets assumptions or inferential bridges shared by a wider GRE component rather than one incidental implementation.

Table 24.21 summarizes the evidential families developed in this section. The table does not assign automatic verdicts. It identifies what must become harder to explain away if GRE is to remain an answerable research programme.

24.21.1 Persistent Failure of Relational Explanations

Relationality is central to GRE, but a central commitment should face correspondingly strong tests. A relational explanation claims more than the existence of social, institutional, historical, material, or technical connections. It claims that a specified relation, relational configuration, or history-bearing position contributes explanatory discrimination to the phenomenon under study. Persistent failure occurs when that contribution cannot be established even after boundary, scale, semantics, persistence, and missingness have been examined carefully.

Definition 24.522 (Relational defeat comparison). A *relational defeat comparison*

evaluates a GRE relational explanation against at least one serious non-relational or mixed rival under a common target, evidential base, scope, and outcome criterion, while preserving differences in complexity, observability, and auxiliary assumptions.

The relevant criterion is not merely predictive fit. A relational model can fit well because it contains a flexible representation of context, while a simpler institutional, material, technical, or compositional account identifies the operative mechanism more directly. Conversely, a non-relational model may predict accurately while a relational reconstruction better explains intervention sensitivity or historical change. Defeat therefore concerns the inferential task actually claimed: description, mechanism identification, counterfactual explanation, historical reconstruction, intervention, or transport.

Definition 24.523 (Persistent relational explanatory failure). *Persistent relational explanatory failure* occurs when, across appropriately varied cases and after explicit relational specification, GRE relational accounts repeatedly fail to add reliable discrimination, mechanism reconstruction, counterfactual leverage, or transportability beyond serious non-relational or mixed alternatives.

One isolated superiority result for a rival is insufficient. More serious evidence would include repeated findings that relation semantics do not survive direct measurement, relational variables cease to matter when relevant material or institutional mechanisms are represented, intervention on the alleged relation does not alter the predicted consequences, or relational reconstructions produce no stable implications not already available from simpler accounts.

Proposition 24.524 (Relational defeat condition). *If relational specifications repeatedly lose their claimed explanatory advantage under serious comparison after boundary, scale, semantics, missingness, and mixed-mechanism checks, GRE should lower the status of relational priority for that class of phenomena rather than broaden the meaning of relation until the rival explanation is redescribed as relational.*

The implication can remain domain-bounded. GRE need not abandon relational analysis because it fails for one class of objects. But persistent failure across distinct domains would bear on the broader claim that relational organization is a privileged explanatory starting point rather than one useful analytical option among others.

24.21.2 Failure of Generative Distinctions

GRE gives special analytical weight to generation: the production of later capacities, relations, value forms, institutions, roles, or possibilities that cannot be adequately represented as simple transfer or persistence. This distinction is valuable only if it can exclude neighbouring processes in practice. A vocabulary that labels any consequential historical change as generative would be too permissive to carry explanatory force.

Definition 24.525 (Generative discriminability test). A *generative discriminability test* asks whether the evidence and conceptual typing can distinguish the proposed generation from serious alternatives such as transfer, conversion, revelation, selection, persistence, recombination, redistribution, reclassification, substitution, or measurement change.

The test can be conceptual, empirical, historical, or formal. For example, a capability said to have been generated should not have been merely latent and newly observed; a relation said to have been generated should not be a reclassification of an earlier relation under changed terminology; a new value form should not be a renamed manifestation of an existing form unless the distinction is analytically warranted.

Definition 24.526 (Generative category collapse). *Generative category collapse* occurs when recurrent GRE applications cannot identify stable exclusion conditions separating generation from adjacent process types, so that the generative label contributes little beyond the observation that a later state differs from an earlier one.

Generative category collapse would be stronger counterevidence than occasional ambiguity. Historical processes often combine generation, conversion, transfer, and persistence. The problem arises when even carefully selected cases with process evidence cannot sustain the distinction, or when the classification depends principally on whether the analyst regards the later outcome as novel or important.

Proposition 24.527 (Generative defeat condition). *When repeated applications with adequate process evidence cannot distinguish generation from serious neighbouring mechanisms, the relevant GRE generativity claim should be narrowed or retyped; if the failure recurs across core domains, the generativity architecture itself requires programme-level reconsideration.*

The evidential burden is therefore asymmetric in a useful way. GRE need not show that every historical novelty has one pure mechanism. It must show that calling a process generative adds a discriminating claim that could have been false.

24.21.3 Failure of Value-Conversion Analysis

Value conversion is one of GRE's most distinctive substantive claims: heterogeneous value forms can be connected through interfaces and conditions without assuming prior equivalence. Section 24.11 established a demanding identification architecture for such claims. The present issue is what would count against that architecture rather than merely make one conversion estimate uncertain.

Definition 24.528 (Conversion defeat profile). A *conversion defeat profile* records whether source and target forms remain stably typed, whether an interface can be independently reconstructed, whether intermediate transformation evidence exists, whether source-side and target-side changes behave as predicted, and whether simpler rival mechanisms explain the same observations with fewer unsupported assumptions.

A conversion claim weakens when source and target types shift whenever empirical patterns change, when the alleged interface cannot be distinguished from ordinary transfer or institutional recognition, or when observed target changes persist after source exposure is removed and are better explained by target-side generation or common causes. It also weakens when multiple incompatible conversion narratives fit the same evidence and no discriminating observation can be specified.

Definition 24.529 (Conversion analytical redundancy). *Conversion analytical redundancy* occurs when a proposed value-conversion account yields no reliable explana-

tory or empirical discrimination beyond a simpler account of transfer, co-production, recognition, pricing, substitution, or correlated change.

Redundancy would not show that value forms are homogeneous. It would show that the conversion mechanism claimed by GRE is not doing independent analytical work in the affected setting.

Proposition 24.530 (Value-conversion defeat condition). *If well-specified source–interface–target analyses repeatedly fail to distinguish conversion from serious rivals, or if the required value typing changes ad hoc to preserve the mechanism, GRE should withdraw or narrow the conversion claim rather than treat heterogeneous endpoint change as conversion by default.*

A stronger programme-level problem would arise if conversion analysis repeatedly adds complexity without improving mechanism identification across domains central to GRE's value architecture. That result would not imply that values are commensurable; it would imply that the present conversion formalism is an inadequate way to represent their interaction.

24.21.4 Failure of Multiscale Claims

GRE frequently moves among persons, organizations, institutions, communities, political economies, infrastructures, ecological systems, and historical trajectories. Such movement is analytically useful only when cross-scale relations are reconstructed rather than assumed. A pattern at one scale does not automatically aggregate upward, and a macro-level pattern does not automatically decompose into the same mechanism at lower levels.

Definition 24.531 (Multiscale bridge claim). *A multiscale bridge claim specifies how a GRE property, mechanism, or state at one analytical scale is expected to compose, mediate, transform, constrain, or emerge at another scale, including the aggregation or disaggregation rule and the conditions under which it is expected to hold.*

Counterevidence includes systematic ecological or atomistic fallacies, non-reproducibility of individual-level mechanisms at institutional scale, macro-patterns that persist despite reversal of the proposed micro-mechanism, or scale-dependent category changes that invalidate the assumed bridge. A relation can change meaning across scales; so can power, participation, value, generativity, and resilience.

Definition 24.532 (Scale-coherence failure). *A scale-coherence failure occurs when a GRE cross-scale claim cannot maintain a justified bridge between levels because aggregation, decomposition, mediation, or emergence behaves systematically differently from the stated mechanism.*

Scale-coherence failure does not require that all scales share one ontology or metric. It requires the claimed bridge to survive its own assumptions. If GRE asserts that individual capability generation aggregates into institutional capability, for example, then coordination, substitution, distribution, organizational rules, and collective-action mechanisms become part of the bridge rather than removable detail.

Proposition 24.533 (Multiscale defeat condition). *Repeated scale-coherence failure should lower the warranted scope of the relevant cross-scale GRE claim; where such failures recur across multiple core concepts, GRE should revise its multiscale architec-*

ture rather than infer higher- or lower-level mechanisms from formal similarity alone.

24.21.5 Superior Rival Explanations

A research programme should be corrigible not only by direct contradiction but by better explanation. GRE therefore needs a way to recognize when a rival account provides stronger explanatory performance within a declared scope. Rival superiority cannot be reduced to one metric because explanatory tasks differ, but neither should GRE protect itself by changing the criterion whenever a rival performs better.

Definition 24.534 (Rival-explanation superiority profile). *A rival-explanation superiority profile compares GRE and a serious rival with respect to the inferential task at issue, empirical discrimination, mechanism specificity, predictive or retrodictive adequacy where relevant, intervention sensitivity, historical fit, transportability, conceptual clarity, auxiliary assumptions, and capacity to accommodate counterevidence without semantic expansion.*

Parsimony alone is not decisive. A richer GRE reconstruction can be warranted when the additional relational or historical structure yields new discrimination. Conversely, complexity becomes a liability when it mainly absorbs exceptions. Rival superiority is therefore strongest when the rival explains the observations at least as well while specifying clearer mechanisms, making riskier successful predictions, requiring fewer ad hoc repairs, or travelling more reliably across the relevant conditions.

Definition 24.535 (Explanatory replacement pressure). *Explanatory replacement pressure arises when a rival explanation repeatedly dominates the GRE account on the criteria material to the stated research objective and the GRE account cannot recover its claimed advantage through independently justified specification.*

Replacement pressure can be local. GRE can remain useful as a descriptive, normative, historical, or interface language even when another theory explains a particular mechanism better. But an open programme should acknowledge the division of explanatory labour rather than insist that every economically relevant mechanism be reconstructed as distinctively GRE.

Proposition 24.536 (Rival-superiority defeat condition). *Where a serious rival repeatedly explains the same target with greater discriminating power, clearer mechanism, stronger transport, or fewer unsupported auxiliary assumptions, the corresponding GRE claim loses explanatory priority within that scope unless GRE can identify an independently warranted contribution not supplied by the rival.*

24.21.6 Domain-Specific Counterexamples

Chapter 23 and Section 24.16 made cross-domain correction part of GRE's architecture. A receiving domain can therefore supply evidence that an exported GRE concept changes meaning, misses constitutive structure, or produces false inference. Such counterexamples should narrow portability rather than be dismissed as insufficiently economic.

Definition 24.537 (Domain-specific counterexample). *A domain-specific counterexample is a receiving-domain case in which a GRE concept or cross-domain candidate, applied under its stated transfer conditions, yields a false, misleading, non-*

discriminating, or constitutionally incomplete inference according to independently warranted domain evidence.

One failed transfer usually defeats a portability claim, not the originating GRE concept. An economic notion of participation can remain useful economically even if it fails to capture political participation. A conversion framework can remain useful in markets while proving inadequate for ecological restoration. The escalation question is whether the failure targets a local translation rule or a purportedly general structure.

Definition 24.538 (Counterexample propagation map). A *counterexample propagation map* identifies which GRE export, cross-domain candidate, or underlying GRE premise is affected by a domain-specific counterexample and which neighbouring claims remain independent of that failure.

This map protects both openness and restraint. It prevents a receiving domain from being treated as a mere application field, but it also prevents every failed transfer from being narrated as evidence against GRE's economic core.

Proposition 24.539 (Domain-counterevidence condition). *When independently warranted receiving-domain evidence repeatedly rejects the structure required by a GRE transfer claim, the transfer scope should contract; recurrence across semantically independent domains can count against a purported cross-domain invariant even when the originating economic concept remains locally adequate.*

24.21.7 Empirical Non-Replication

Replication is especially difficult for GRE because many claims are historical, relational, context-sensitive, and mechanism-specific. Context sensitivity, however, cannot be allowed to make non-replication irrelevant by definition. The relevant question is what kind of stability the original claim asserted and whether the replication design preserves the conditions required to test that stability.

Definition 24.540 (GRE replication profile). A *GRE replication profile* records the original claim, target mechanism, measurement and representation choices, relational and institutional conditions, historical regime, replication design, preserved and changed scope conditions, and the inferential implication of convergence or divergence between studies.

Replication can be exact where records and procedures permit, conceptual where the mechanism is instantiated differently, multi-site across contemporaneous contexts, or historical across regimes. No form is automatically superior. Exact replication can reproduce the same measurement bias; conceptual replication can test portability but change too many conditions; historical replication can reveal regime dependence but rarely reproduces identical interventions.

Definition 24.541 (Non-replication escalation condition). A *non-replication escalation condition* is reached when adequately powered or evidentially rich replications that preserve the relevant scope conditions repeatedly fail to recover the GRE pattern or mechanism, while plausible measurement, implementation, and contextual explanations for the divergence have been examined and do not account for the result.

Non-replication can therefore produce several revisions: narrowing transportabil-

ity, changing measurement, retyping the mechanism, adding a genuine moderator, or abandoning the claim. The repair becomes problematic when a new moderator is introduced after every failure without independent evidence.

Proposition 24.542 (Replication defeat condition). *Repeated, well-diagnosed non-replication should lower the warranted status of the affected GRE empirical claim, and unexplained recurrence across settings that were within its declared scope should count as counterevidence rather than be absorbed indefinitely through post hoc contextual qualification.*

24.21.8 Internal Inconsistency

GRE can also face counterevidence from within its own architecture. A framework assembled across ontology, epistemology, value theory, power, justice, formalism, and praxis can contain commitments that cannot all be maintained simultaneously. Internal inconsistency is not empirical falsification, but it can undermine the inferential legitimacy of conclusions derived from incompatible premises.

Definition 24.543 (GRE internal-consistency audit). *A GRE internal-consistency audit identifies commitments that jointly constrain the same claim and tests whether their definitions, typing rules, scope conditions, inferential roles, and revision principles can be satisfied simultaneously without equivocation.*

Potential tensions include ontological suspension combined with unqualified ontological language in formal models; value plurality combined with hidden scalar aggregation; domain containment combined with universal export of GRE concepts; normative underdetermination combined with unmarked substantive prescriptions; or methodological pluralism combined with asymmetric dismissal of inconvenient evidence. Some tensions are terminological and repairable. Others can require choosing between commitments.

Definition 24.544 (Architectural inconsistency). *An architectural inconsistency exists when two or more GRE commitments that are jointly necessary for a class of claims cannot be maintained together under stable semantics and declared scope, so that preserving one requires weakening, retyping, or abandoning another.*

A framework can tolerate open questions and incomplete formalization; it cannot treat contradiction as evidence of richness. The appropriate response is to localize the inconsistency, determine which claims depend on it, and revise at the least destructive level consistent with restored coherence.

Definition 24.545 (Consistency-repair hierarchy). *A consistency-repair hierarchy orders candidate responses from clarification of terminology and scope, through retyping of claims and removal of auxiliary assumptions, to revision of a core concept or architectural commitment when weaker repairs do not restore coherent inference.*

Proposition 24.546 (Internal-inconsistency defeat condition). *When a GRE conclusion depends on mutually incompatible commitments and the inconsistency cannot be removed through stable clarification, narrowing, or retyping, the affected conclusion loses warrant; recurrent architectural inconsistencies that require ad hoc exceptions constitute evidence for programme-level revision.*

The eight defeat families provide a bridge between limitation and revision. They

do not establish that GRE is false as a whole, because GRE is a layered and revisable research programme rather than one indivisible proposition. They do establish that its components can lose warrant. The strongest counterevidence is therefore not a dramatic single anomaly, but a pattern in which a core GRE distinction repeatedly fails to discriminate, a rival repeatedly explains more with fewer unsupported assumptions, receiving domains independently reject a claimed invariant, empirical results do not replicate within declared scope, or the framework cannot maintain its own commitments coherently.

Proposition 24.547 (Programme-level counterevidence principle). *Counterevidence should be escalated from a local claim to a wider GRE component only when the defeated claims share the relevant assumption or inferential bridge, the adverse pattern recurs under appropriate tests and repairs, and preserving the component would otherwise require semantic expansion, asymmetric evidential standards, or accumulating ad hoc exceptions.*

The next section asks which such patterns would require major revision of GRE's core architecture rather than local withdrawal, regionalization, or replacement of one analytical component.

24.22 Architectural Revision Conditions

Section 24.21 identified evidential defeat conditions that can lower the warrant of a GRE claim, mechanism, or component. The role of the present section is to specify a stronger threshold: when repeated defeat can no longer be handled adequately by local narrowing, retyping, domain restriction, replacement of one model, or retirement of one subsidiary concept, but instead requires revision of the architecture through which Generative Relational Economics organizes its objects and inferences. The objective is not to protect an inherited framework by making architectural revision remote. It is to distinguish proportionate revision from indiscriminate abandonment. The section therefore examines eight core architectures: ontological distinctions, manifestation, research and praxis, generative attribution, value plurality, power conversion, domain containment, and the book's core vocabulary. The method is dependency-sensitive. A major revision is warranted when recurrent failures target assumptions shared by a sufficiently broad class of claims and weaker repairs cease to restore stable discrimination, coherent inference, or empirical answerability.

Definition 24.548 (GRE architectural revision). *A GRE architectural revision is a change to a core distinction, typing rule, dependency relation, inferential bridge, or organizing vocabulary whose alteration requires systematic reconsideration of multiple downstream GRE claims rather than correction of one application, model, domain transfer, or auxiliary assumption.*

Architectural revision is therefore dependency-based rather than dramatic by definition. Replacing an elaborate formalism can remain local if few substantive claims depend on it. By contrast, revising the distinction between relational reality and manifestation may affect epistemology, empirical identification, model interpretation, historical reconstruction, and praxis even if the textual change is concise. The relevant

quantity is the structure of dependence, not the rhetorical prominence of the concept.

Definition 24.549 (Major-revision threshold). A *major-revision threshold* is reached when a core GRE commitment is implicated in recurrent, independently supported defeat across materially different applications; reasonable local repairs have been attempted; preserving the commitment requires semantic expansion, incompatible exceptions, asymmetric evidential standards, or loss of discrimination; and revising the commitment would alter a substantial downstream claim family.

The threshold has both evidential and architectural components. A widely used concept does not require major revision merely because it is important, and repeated anomalies do not require it merely because they are numerous. The anomalies must bear on the shared commitment itself rather than on unrelated implementation defects. Conversely, a framework should not postpone architectural revision indefinitely by redescribing every recurrent challenge as context dependence.

Table 24.22 is diagnostic rather than exhaustive. Several architectural failures can occur together. A breakdown in the manifestation framework can weaken empirical identification; instability in value typing can undermine conversion and circulation; failure of domain containment can reveal that the core vocabulary changes meaning too strongly across domains to sustain the existing interfaces. Architectural revision should therefore trace dependency among failures rather than count them independently.

Definition 24.550 (Architectural revision dossier). An *architectural revision dossier* records the challenged commitment, affected claim family, independent defeat evidence, repairs already attempted, recurring exceptions, rival architectures, downstream dependencies, claims likely to survive revision, claims requiring re-derivation, and evidence that could discriminate among candidate replacements.

This dossier makes a major revision a research object rather than an act of theoretical preference. It also preserves continuity: a revised GRE need not discard every earlier result. Some empirical findings, historical reconstructions, or local mechanisms may survive even when the conceptual architecture through which they were first interpreted changes.

24.22.1 Ontological Layer Adequacy

GRE has relied on a restrained three-level orientation: ultimate ontology remains suspended; sufficiently persistent and causally efficacious configurations can be treated as relationally real; and those configurations become accessible through historically situated manifestations. Section 24.2 clarified that this architecture is methodological and explanatory before it is ontological. Major revision would nevertheless be required if the distinctions themselves repeatedly failed to support different inferential tasks.

Definition 24.551 (Ontological-layer discriminability). *Ontological-layer discriminability* is the capacity of GRE's ontological architecture to distinguish, for a declared research task, claims about ultimate constitution, claims about relatively stable relational reality, and claims about manifested or epistemically accessible presentation without shifting the same proposition among layers merely to preserve it from

Table 24.22: Core GRE architectures and indicative conditions for major revision.

Architecture	Indicative recurrent failure	Architectural consequence if sustained
Ontological distinctions	Relational reality, manifestation, and suspended ontology cannot be applied with stable exclusion conditions or different inferential roles	Replace or reorganize the layered ontology and propagate the change through epistemology and formal interpretation
Manifestation framework	Manifestation relations cannot be reconstructed, compared, or distinguished from constitution, representation, or intervention across core cases	Rebuild the access architecture around another account of appearance, mediation, or co-constitution
Research–praxis boundary	Inquiry and intervention cannot be separated sufficiently for consequential claims, even with reflexivity and participation modeled explicitly	Replace the boundary with a unified epistemic–practical event architecture and revise evidential standards
Generative attribution	Generation repeatedly fails to discriminate from transfer, conversion, selection, revelation, recombination, or persistence across central applications	Reduce, decompose, or abandon generativity as GRE's principal process distinction
Value plurality	Typed heterogeneous value neither stabilizes empirically nor improves comparison relative to warranted common measures or better alternative classifications	Reconstruct the value architecture, including conversion, circulation, aggregation, and justice interfaces
Power conversion	Asymmetry, capacity, dependence, and control do not support stable mechanism-based transitions into the power relations claimed by GRE	Rebuild the power genealogy and its links to conversion, circulation, governance, and justice
Domain containment	Claim-specific economic jurisdiction and receiving-domain correction cannot be localized without persistent circularity or arbitrary boundary drawing	Replace domain containment with a different problem-space or interface architecture
Core vocabulary	Multiple foundational terms require recurrent semantic stretching, overlap, or retirement and no stable typing system restores discrimination	Re-found the vocabulary and systematically translate, revise, or withdraw dependent claims

criticism.

The distinction would be weakened if a supposedly relationally real object could be identified only by the same manifestation whose adequacy was in question, if manifestations were treated as ontologically secondary when convenient but constitutive when contrary evidence appeared, or if ontological suspension coexisted systematically with substantive ontological conclusions imported through formal language. Occasional ambiguity is expected. The architectural concern arises when the layer as-

signment becomes an after-the-fact device rather than a stable inferential discipline.

A second challenge would arise from repeated evidence that the phenomena GRE analyzes are better reconstructed through ontological categories that do not map coherently onto the three-level architecture. Domain-specific material, biological, legal, technical, phenomenological, or ecological constitutions may sometimes require such categories locally. Major revision would become relevant only if the same problem recurred across core GRE objects and the layer architecture ceased to clarify what could be claimed, observed, or revised.

Definition 24.552 (Ontological-layer collapse). *Ontological-layer collapse* occurs when the distinctions among ontological suspension, relational reality, and manifestation fail recurrently to produce stable differences in evidential burden, explanatory role, or revision condition across the claims that depend on them.

Layer collapse would not by itself establish a competing ontology. It would show that GRE's present architecture no longer earns its complexity. Candidate revisions could include a graded ontology, a process ontology with explicit epistemic interfaces, a domain-indexed ontological architecture, or a less ontologically loaded theory of analytical objects. The replacement should be judged by whether it restores discrimination without making stronger metaphysical claims than the evidence warrants.

Proposition 24.553 (Ontological architectural-revision condition). *When ontological-layer assignments repeatedly fail to constrain inference or revision after explicit typing and domain-specific testing, GRE should revise the layer architecture itself rather than preserve it through case-by-case reassignment; downstream claims that depend on relational-reality or manifestation status should then be re-derived under the replacement architecture.*

24.22.2 Manifestation Architecture Adequacy

The manifestation framework is more specific than general epistemic humility. It proposes that relational reality is not accessed without mediation and that the relation between a target and its manifestations is historically variable, potentially non-invertible, and sometimes performative. Section 24.4 developed this into a disciplined account of representation and reverse inference. Major revision would be necessary if manifestation ceased to be a useful middle category between relational reality and representation.

Definition 24.554 (Manifestation separability). *Manifestation separability* is the extent to which GRE can distinguish the process through which relational differences become available from the subsequent representation, classification, measurement, narration, or modelling of those available differences, while allowing the two processes to interact.

The distinction can fail in both directions. Some phenomena may be constituted through the very classificatory, symbolic, legal, or technical practices that make them observable, so that manifestation cannot be treated as a merely downstream presentation of a prior relational object. Conversely, some empirical settings may offer sufficiently direct operational access that a separate manifestation layer adds no explanatory discrimination beyond ordinary measurement and representation theory.

The stronger challenge concerns systematic non-reconstructability. A manifestation relation can be many-to-one or historically changing without being useless. It becomes architecturally problematic when no stable constraints can be placed on the class of target configurations compatible with observed manifestations, when manifestation changes cannot be distinguished from target change even under comparative evidence, or when the same evidence can be assigned freely to manifestation error or relational transformation depending on which preserves the GRE claim.

Definition 24.555 (Manifestation redundancy). *Manifestation-framework redundancy* occurs when a manifestation analysis repeatedly adds no inferential discrimination beyond a simpler representation, measurement, or constitutive-practice account, while introducing no independently testable bridge assumptions or revision conditions.

A replacement framework might treat appearance and representation as one mediated epistemic process, model target and manifestation as jointly constituted in some domains, or retain manifestation only for cases where it performs identifiable analytical work. Major revision need not require uniform treatment across domains; it may instead require GRE to abandon the assumption that one manifestation architecture travels across all economic objects.

Proposition 24.556 (Manifestation architectural-revision condition). *If the manifestation layer recurrently cannot be distinguished from constitution or representation, or if it cannot support bounded reverse inference under cases where GRE depends on it, the framework should be decomposed, regionalized, or replaced rather than retained as a universal mediation layer.*

24.22.3 Research–Praxis Boundary Adequacy

GRE distinguishes inquiry from praxis because the warrants for describing a system are not identical to the warrants for intervening in it. The distinction also supports the book's separation between observation or readout and state-changing transformation. Yet reflexive social and economic systems complicate the boundary: measurement can alter incentives, classification can change standing, publication can change expectations, participatory inquiry can generate relations, and AI-mediated research can become operational infrastructure.

Definition 24.557 (Research–praxis boundary). The *research–praxis boundary* separates epistemic acts whose principal declared role is to investigate, represent, or evaluate a system from practical acts whose principal declared role is to alter its states, relations, institutions, allocations, or possibilities, while allowing that one event can have effects on both sides.

The boundary is therefore functional rather than metaphysically sharp. A survey can be principally research while changing salience; a pilot programme can be principally intervention while generating evidence; a legal classification can simultaneously represent and transform. These mixed cases do not defeat the distinction if the epistemic and practical roles, consequences, and responsibilities can still be typed separately.

Major revision would become necessary if, across central GRE settings, attempts to

separate research from praxis systematically distort the object because inquiry itself is constitutive of the relations being studied, or because the evidential process and practical transformation form one inseparable event. In such cases the appropriate architecture may be a joint epistemic–practical event model rather than two domains connected by reflexive effects.

Definition 24.558 (Epistemic–practical inseparability). *Epistemic–practical inseparability* exists when the evidence-producing act and the materially relevant transformation are generated through the same mechanism such that attributing the event to research or praxis separately removes information necessary to explain its consequences, responsibilities, or evidential status.

This condition is stronger than ordinary observer effects. It would matter, for example, where an audit creates the compliance architecture whose effect is being measured, where participatory research generates the collective subject whose preferences are later recorded, or where predictive publication changes the market relation whose dynamics supposedly validate the prediction. The proper revision would preserve both epistemic and practical dimensions as jointly typed rather than treating one as noise around the other.

Proposition 24.559 (Research–praxis architectural-revision condition). *When central GRE objects repeatedly exhibit epistemic–practical inseparability and the existing research–praxis distinction cannot preserve causal attribution, evidential status, and responsibility simultaneously, GRE should replace the binary boundary with a joint event architecture while retaining explicit typing of epistemic and practical consequences.*

24.22.4 Generative Attribution Adequacy

Generativity is the most distinctive process commitment of GRE. The framework is organized around the possibility that economic processes do not merely allocate existing resources or transfer existing value but generate capacities, relations, institutions, value forms, roles, and future possibilities. Sections 24.11, 24.12, and 24.18 have imposed increasingly demanding mechanism and identification burdens on those claims. Architectural revision would be required if generation itself failed as a stable process category.

Definition 24.560 (Generative-core adequacy). *Generative-core adequacy* is the capacity of the GRE generativity architecture to identify a class of processes whose explanatory content cannot be reduced, without material loss, to transfer, conversion, selection, revelation, recombination, persistence, redistribution, substitution, or reclassification.

Generativity can be mixed with these neighbouring processes and still remain distinctive. Education can reveal existing capability while generating new capability; institutions can recombine earlier elements while creating novel coordination possibilities; technological systems can transfer resources while generating new dependencies. The architectural issue is whether an independently meaningful generated object and mechanism can be identified after such mixtures are decomposed.

A major challenge would arise if repeated empirical studies found that alleged generation consistently decomposes into already available processes with no residual

mechanism, or if the generated object can be identified only by retrospective novelty judgments. Another challenge would arise if different domains require such incompatible meanings of generation that no shared GRE process architecture remains after semantic reconstruction.

Definition 24.561 (Generative-core dissolution). *Generative-core dissolution* occurs when, after mechanism typing and serious rival decomposition, the residual class of processes requiring a distinct generative category becomes empirically empty, conceptually unstable, or too heterogeneous to sustain common inferential rules across GRE's central economic applications.

A revision could respond at several levels. GRE might regionalize generativity into narrower process families, subordinate it to a more general theory of historical transformation, or retain generation only as an empirical predicate rather than the framework's organizing economic perspective. Such revision would affect value generation, generative allocation, capability formation, generative spacetime, and parts of the power and justice architecture; it would therefore be major even if many local empirical results survived.

Proposition 24.562 (Generative architectural-revision condition). *If generation repeatedly adds no stable explanatory discrimination after decomposition against serious neighbouring processes across GRE's central domains, the framework should revise the generative core rather than preserve it through increasingly broad definitions of novelty or historical change.*

24.22.5 Value-Plurality Architecture Adequacy

GRE's value architecture is deliberately heterogeneous. It allows multiple value forms, conversion without prior equivalence, partial commensuration, residual value, and domain-specific evaluative authority. Sections 24.9 and 24.10 also made the taxonomy revisable. Major revision would become necessary if this plural architecture were persistently less adequate than either a warranted common measure or a different account of evaluative heterogeneity.

Definition 24.563 (Value-plurality architectural adequacy). *Value-plurality architectural adequacy* is the capacity of GRE's typed heterogeneous-value framework to preserve empirically and normatively consequential differences among value forms while supporting more discriminating analyses of realization, conversion, circulation, conflict, and justice than serious simpler or alternative value architectures.

Two opposite patterns could challenge the architecture. One would be strong evidence that apparently heterogeneous value forms are consistently representable through a common measure with stable semantics, acceptable loss, and superior predictive or practical discrimination across the targeted settings. GRE should not preserve plurality merely as a philosophical preference if the relevant distinctions do no work. The other pattern would be excessive instability: value forms might proliferate or shift so strongly that the taxonomy cannot support stable typing, conversion, or comparison and each application requires a new ontology of value.

Definition 24.564 (Value-plurality architecture failure). *Value-plurality architecture failure* occurs when typed value heterogeneity recurrently either adds no material

discrimination beyond a warranted common representation or fails to provide stable enough value identities for the conversion, circulation, comparison, and justice claims that depend on it.

The revision need not choose between universal scalarization and unlimited plurality. Candidate replacements include a smaller set of context-indexed value families, multidimensional value spaces with explicit bridge rules, domain-specific value ontologies connected only by partial mappings, or process-centered accounts that treat some apparent value forms as stages of realization rather than distinct kinds.

Proposition 24.565 (Value-architecture revision condition). *When heterogeneous-value typing recurrently fails either through analytical redundancy or through instability that prevents downstream mechanism identification, GRE should revise the value architecture and re-evaluate conversion, circulation, aggregation, power, and justice claims that presuppose the affected value distinctions.*

24.22.6 Power-Conversion Architecture Adequacy

GRE develops power from typed asymmetry, historically situated capacity, relational realization, and mechanisms through which one position conditions another's economically relevant possibilities. Section 24.13 resisted both the claim that every asymmetry is power and the claim that only direct control qualifies. Major revision would be required if the pathway from asymmetry and capacity to realized power could not be reconstructed with stable mechanism types across central applications.

Definition 24.566 (Power-conversion architecture). The *power-conversion architecture* is the GRE account of how resources, positions, informational advantages, recognition, institutional roles, infrastructural control, timing, exit conditions, or other typed asymmetries can, under identifiable relational conditions, become capacities that materially condition another position's feasible possibilities.

The phrase conversion does not imply conservation or one common power substance. It identifies a transition from an asymmetry or potential capacity into relationally realized conditioning. The architecture is challenged if those transitions cannot be distinguished from productivity differences, voluntary coordination, shared constraints, institutional rule-following, or third-party enforcement, or if the relevant mechanism varies so radically that one power genealogy obscures rather than clarifies the phenomena.

A further challenge concerns composition. GRE permits conversion power, circulation power, recognition power, infrastructural power, epistemic power, and other typed mechanisms to interact without requiring scalarization. If empirical analysis shows that these mechanisms do not share even a minimal relational kernel, or conversely that a simpler established power theory explains their transitions more coherently, the existing architecture may be unnecessary.

Definition 24.567 (Power-genealogy breakdown). *Power-genealogy breakdown* occurs when repeated GRE applications cannot establish a stable inferential path from typed asymmetry through credible capacity and mechanism to consequential relational conditioning, or when the proposed path adds no discrimination beyond serious alternative power accounts.

The appropriate response could be to separate several power families, make power fully domain-specific, revise the role of asymmetry as a precursor, or import a stronger external theory while retaining only GRE-specific analyses of economic incidence and value interfaces. Such revision would propagate into governance, justice, AI-era asymmetry, conversion, circulation, institutional analysis, and criticality-related applications.

Proposition 24.568 (Power architectural-revision condition). *If the asymmetry–capacity–mechanism–conditioning genealogy repeatedly fails to discriminate realized power from serious alternatives across central GRE applications, the power architecture should be re-founded rather than preserved by relabeling heterogeneous causal influence as power.*

24.22.7 Domain-Containment Architecture Adequacy

Chapter 23 treated GRE as a domain-specific research programme whose principal problem-space is economic while maintaining explicit interfaces with history, governance, law, political theory, education, ecology, AI studies, social theory, aesthetics, and other domains. Section 24.16 then made receiving-domain correction authority part of transfer discipline. This architecture presupposes that claim-specific economic jurisdiction can be identified even where empirical objects are shared.

Definition 24.569 (Domain-containment adequacy). *Domain-containment adequacy* is the capacity to identify a materially coherent economic problem-space, specify which predicates and inferences fall within GRE warrant, preserve neighboring-domain authority over their own predicates, and trace cross-domain dependencies without arbitrary or circular boundary assignment.

The architecture would be challenged if central GRE objects repeatedly turned out to be constitutively inseparable from legal, political, ecological, educational, social, technical, or normative predicates such that economic claims could not be typed independently even provisionally. It would also be challenged if correction authority could not be localized because each domain's object was recursively constituted by all the others at the same inferential level.

This possibility should not be exaggerated. Interdependence does not imply domain collapse. A property regime can be jointly legal, political, social, and economic while still supporting different claim-specific questions. Major revision is warranted only when the distinction among problem-spaces ceases to constrain inference and the interface architecture becomes a bookkeeping device around an effectively undifferentiated object.

Definition 24.570 (Domain-containment breakdown). *Domain-containment breakdown* occurs when recurrent core cases cannot support stable claim-specific jurisdiction or provenance-preserving correction without arbitrary boundary placement, so that the distinction between GRE and its neighboring domains no longer organizes evidential or explanatory responsibility.

A replacement could organize inquiry around problems, mechanisms, or event complexes rather than disciplinary domains. GRE might then become one economic lens within a more explicitly multi-domain relational programme, or its concepts

might be partitioned into several neighboring research programmes with no privileged economic center. Such a change would affect the programme's identity, not merely one export rule.

Proposition 24.571 (Domain-containment architectural-revision condition). *When claim-specific economic jurisdiction and correction authority cannot be stabilized across GRE's central objects despite explicit predicate typing, the framework should revise its domain-containment architecture rather than preserve disciplinary identity through arbitrary boundary assertions.*

24.22.8 Core-Vocabulary Re-Foundation

The strongest revision concerns GRE's vocabulary itself. Relation, generation, value, conversion, circulation, power, participation, field, spacetime, and manifestation organize much of the book, but they should remain revisable infrastructure rather than protected identity.

Definition 24.572 (Core-vocabulary stress). *Core-vocabulary stress* is recurrent reliance on semantic stretching, overlapping redefinitions, incompatible domain-specific meanings, or auxiliary distinctions to preserve claims a foundational term was intended to clarify.

New subtypes can reveal structure, but repeated qualifications may instead show that distinct objects or mechanisms were grouped under one label. Decomposition may then be preferable to further expansion.

Conceptual duplication creates the opposite pressure: if several GRE terms repeatedly collapse into one better-specified mechanism, the framework should permit merger rather than preserve terminology for continuity.

Definition 24.573 (Vocabulary re-foundation condition). A *vocabulary re-foundation condition* is reached when multiple core terms simultaneously exhibit discriminatory depletion, unstable typing, recurrent overlap, or clearer replacements, so that local redefinition would leave the wider inferential architecture inconsistent or opaque.

Re-foundation should preserve a translation record marking earlier claims as preserved, narrowed, retyped, decomposed, merged, or withdrawn.

Definition 24.574 (GRE architectural revision ladder). The *GRE architectural revision ladder* orders responses from local correction and narrowing through retyping, regionalization, component replacement, core-architecture revision, coordinated revision, and vocabulary re-foundation.

The ladder does not privilege minimal change; accumulated patches can become more ad hoc than revision of their shared commitment.

Proposition 24.575 (Proportionate architectural revision principle). *GRE should adopt the least extensive revision that restores stable semantics, empirical discrimination, coherent inference, and appropriate domain and normative authority; when local repair requires accumulating ad hoc exceptions, revision should escalate to the shared architecture on which the defeated claims depend.*

Major revision remains compatible with continuity when reasons are explicit and dependent claims re-evaluated. GRE should prioritize answerability over loyalty to a fixed ontology, vocabulary, or formalism. Section 568 develops this agenda.

24.23 Scope-Conditioned GRE Research Programme

Chapter 24 has treated limits as part of the substantive content of Generative Relational Economics rather than as qualifications appended after the theory has already been stated. The preceding sections identified distinct ontological, epistemic, manifestational, relational, historical, formal, value-theoretical, power-theoretical, normative, practical, cross-domain, AI-era, and empirical limits; they then specified recurrent failure modes, evidential defeat conditions, and circumstances that would require architectural revision. The role of the present section is to convert that critical record into a positive research programme while preserving the scope conditions that made the criticism meaningful. Its objective is not to repeat the broader research architecture developed earlier in the book, nor to anticipate the programme-wide synthesis of Chapter 25. It is narrower and more operational: each identified limit should become a question, research direction, collaboration point, defeat test, interface obligation, historical revalidation task, or candidate for future theory. The method is therefore limitation-derived programme construction. What GRE presently cannot establish becomes part of the specification of what future GRE research must learn to establish, distinguish, revise, or decline.

Definition 24.576 (Scope-conditioned research programme). A *scope-conditioned GRE research programme* is a versioned portfolio of questions, studies, formal developments, domain collaborations, replications, counterexample searches, historical revalidations, and theoretical revisions whose admissible claims remain explicitly bounded by the scope conditions, evidential defeat conditions, and architectural revision criteria established for the relevant GRE concepts.

The phrase *scope-conditioned* is essential. An open programme is not a programme in which any relational, generative, or value-related question can be incorporated without constraint. Openness requires identifiable entry conditions and exit conditions. A proposed extension should state which GRE object it develops, what evidence could improve or weaken the claim, which neighboring domain retains authority over imported premises, and how the result would affect dependent claims. The programme is open because its questions and formulations can change, not because its vocabulary is immune to exclusion.

Definition 24.577 (GRE scope-condition register). A *GRE scope-condition register* records, for each consequential claim family, the object and predicate under study, empirical and historical scope, operative definitions, necessary external premises, known limitations, current defeat conditions, revision dependencies, and the conditions under which the claim should be narrowed, retyped, suspended, or withdrawn.

The register gives future research a stable starting point without converting present formulations into canonical doctrine. A successful study may widen a scope condition, narrow it, decompose it, replace one bridge, or show that a previously excluded mechanism should be incorporated. A negative result may be equally informative if it identifies where a mechanism stops working. In this sense, Chapter 24 ends not by eliminating incompleteness but by making incompleteness researchable.

Table 24.23 summarizes the conversion from limitation family to research object and scope discipline. The table is not a priority ranking. Some questions are theoretically central but empirically immature; others are empirically tractable but concep-

Table 24.23: Limitation-derived GRE research programme and corresponding scope discipline.

Limitation family	Priority research object	Scope discipline
Ontological and relational	Relational adequacy, non-relational remainder, layer discriminability, boundary and scale sensitivity	Do not infer ontological primacy from analytical usefulness
Epistemic and manifestational	Hidden relations, inverse problems, representation error, changing manifestation mappings	Keep access, manifestation, representation, and target claims distinct
Historical and formal	Category change, timescales, criticality, closure, parameter meaning, mathematical transfer	Treat validity as regime-bounded until historical and empirical bridges are tested
Value, conversion, and circulation	Value typing, commensuration, conversion mechanisms, transmission paths, capture, regeneration	Preserve non-equivalence and residual value unless independently resolved
Power and justice	Conditioning mechanisms, recognition, participation, power conversion, normative bridges	Separate descriptive power and incidence from normative authority
Applied praxis	Irreversibility, model risk, participation capacity, institutional feasibility, radical uncertainty	Match commitment strength to uncertainty, monitoring, reversibility, and repair capacity
Domain transfer and AI	Receiving-domain semantics, changing capabilities, infrastructure dependence, verification	Preserve external correction authority and claim-specific validity horizons
Empirical and architectural	Identification, replication, rival superiority, programme-level defeat, vocabulary stress	Escalate revision when recurrent defeat targets shared architecture

tually local. Programme design should preserve both kinds rather than rewarding only what is easiest to measure or most readily formalized.

24.23.1 Research Questions Generated by Identified Limits

A limitation becomes scientifically useful when it can be reformulated as a question whose possible answers would change a claim, a method, a scope condition, or a theoretical architecture. Merely restating uncertainty is insufficient. The research question should expose the missing discrimination. If relation identification is uncertain, the question is not simply whether relations matter, but which observable differences would distinguish trust from repeated interaction, dependence from co-membership, or power from ordinary asymmetry. If value conversion is uncertain, the question concerns which process evidence would distinguish conversion from transfer, co-generation, or reclassification. If historical generalization is uncertain, the question concerns which conditions must remain invariant for the proposed mechanism to travel across periods.

Definition 24.578 (Limitation-derived research question). A *limitation-derived re-*

search question is a question generated by an identified boundary, uncertainty, limitation, open problem, failure condition, or architectural stress point and formulated so that materially different answers would imply different GRE claims, scope conditions, methods, or revisions.

This definition excludes questions whose answers cannot affect the framework. A question that merely asks for another illustration of an already accepted concept may extend coverage, but it does not directly address a limit. Limitation-derived questions should instead target a discriminating uncertainty: whether a relation persists across a boundary change, whether an apparent value gain survives a different value taxonomy, whether a field representation adds explanatory information beyond specified local mechanisms, whether power remains identifiable when direct control is absent, or whether a domain-transfer result survives reconstruction under receiving-domain semantics.

Definition 24.579 (Question-to-claim dependency). A *question-to-claim dependency* records which GRE claims would be strengthened, weakened, retyped, narrowed, or left unchanged under the serious answer classes to a limitation-derived research question.

Recording the dependency prevents open problems from becoming detached lists. It also identifies questions whose answers have disproportionate architectural consequences. For example, a local measurement problem may affect one empirical estimate, whereas evidence that the distinction between manifestation and representation cannot be maintained across central cases would propagate much further. Research priority can therefore depend partly on dependency depth rather than only on topical novelty.

Proposition 24.580 (Discriminating-question principle). A *limitation-derived GRE question has greater programme value when its serious answer classes discriminate among competing mechanisms, scope conditions, or architectural choices rather than merely increasing the number of cases describable in existing vocabulary.*

The principle does not imply that descriptive work is secondary. Rich description can reveal previously unknown objects and categories. It means that once a limitation has been identified, the associated research question should preserve the possibility that GRE's present formulation is not the best one.

24.23.2 Limitation-Guided Research Directions

Questions become a research direction when they can be organized into cumulative sequences rather than isolated projects. The limitation architecture of this chapter suggests several such sequences. Relational research can move from relation identification to boundary sensitivity, persistence, higher-order structure, field reconstruction, and mixed explanatory comparison. Value research can move from value-form identification to commensurability, conversion, circulation, residual value, and justice. Historical research can move from reconstruction and category genealogy to timescale analysis, transportability, and revalidation of formal or substantive hypotheses. Formal research can move from schematic representation to semantic typing, identification, empirical parameterization, comparison with simpler models, and eventual abandonment where the added formal structure fails to discriminate.

Definition 24.581 (GRE research-direction packet). A *GRE research-direction packet* specifies a limitation-derived problem family, the present claim status, a sequence of discriminating questions, feasible empirical or formal designs, required domain expertise, expected negative-result value, dependencies among studies, and the criteria for widening, narrowing, or retiring the research direction.

The packet should distinguish foundational and downstream work. A sophisticated model of circulation may be premature if the underlying value forms and transmission semantics remain unstable. A justice comparison may be premature if the incidence of the intervention is poorly reconstructed. Conversely, waiting for complete foundations can indefinitely postpone useful empirical work. The appropriate ordering is therefore dependency-sensitive rather than strictly foundationalist.

Definition 24.582 (Research dependency bottleneck). A *research dependency bottleneck* is an unresolved claim or measurement problem on which several downstream GRE questions materially depend, such that further downstream elaboration would accumulate uncertainty faster than it generates independent discrimination.

Examples include inadequate relation typing, unstable value categories, unknown manifestation mappings, ambiguous conversion interfaces, or an unvalidated historical bridge. Identifying these bottlenecks can prevent a large research programme from becoming formally elaborate while resting on one weak empirical or conceptual hinge.

Proposition 24.583 (Dependency-sensitive research priority). *GRE should assign elevated research priority to unresolved problems that combine high downstream dependency with feasible discriminating evidence, while preserving exploratory work where foundational questions are not yet empirically tractable.*

This creates room for a balanced portfolio. Some studies should test central concepts directly. Some should develop better observations or archives. Some should explore domains in which a concept is likely to fail. Others should build new formal representations only after the relevant semantics are sufficiently stable. Programme coherence arises from explicit dependencies rather than uniform method or topic.

24.23.3 Collaboration Architecture for Unresolved Problems

Many GRE limits are not problems that economics can resolve internally. Legal status, ecological process, educational quality, technical capability, historical category meaning, political legitimacy, aesthetic judgment, and other predicates may be economically consequential while requiring external expertise and warrant. Chapter 23 established the importance of receiving-domain correction. Chapter 24 adds a further reason for collaboration: some GRE questions are underdetermined precisely because their evidence and concepts are distributed across domains.

Definition 24.584 (GRE collaboration interface). A *GRE collaboration interface* specifies the shared research object, the predicates assigned to each participating domain, evidence contributed by each domain, translation assumptions, unresolved semantic differences, decision rights over domain-specific claims, correction pathways, and the GRE conclusions that depend on the collaboration.

Collaboration should therefore not be organized as economics importing facts af-

ter the substantive problem has already been defined. A legal scholar may show that the economic object was misclassified because the relevant right is not transferable. An ecologist may show that a proposed value-conversion account mistakes compensation for restoration. An educator may show that a measured capability proxy does not establish learning. A historian may show that the category used in the analysis did not exist in the relevant period. An AI researcher may show that a supposed capability difference depends on a rapidly obsolete model configuration.

Definition 24.585 (Epistemic division of labour). An *epistemic division of labour* is a collaboration arrangement in which different investigators or domains carry differentiated responsibility for specified evidential, semantic, historical, technical, or normative components of a shared claim while the dependencies among those components remain explicit.

Division of labour should not imply fragmentation. The interface problem itself may require joint reconstruction because the economic consequence is produced by the coupling among legal rules, organizational practices, technical systems, ecological processes, or cultural meanings. In those cases the relation among domains becomes part of the research object.

Definition 24.586 (Collaboration correction protocol). A *collaboration correction protocol* states how a revision in one participating domain's warranted premise propagates into the joint analysis, which dependent GRE claims require re-evaluation, and which claims remain unaffected.

The protocol makes collaboration durable across theoretical change. It also reduces the risk that GRE preserves an imported premise after the source discipline has revised or rejected it. Collaboration thus becomes part of the programme's error-correction architecture rather than a source of disciplinary breadth alone.

Proposition 24.587 (Distributed-warrant collaboration principle). *When a GRE claim materially depends on premises whose strongest warrant lies in neighboring domains, the research design should distribute evidential and correction authority accordingly rather than translating those premises into economic vocabulary and treating them as internally established.*

24.23.4 Defeat-Test Design

Sections 24.20–24.22 made failure modes, counterevidence, and major-revision conditions explicit. The open programme should therefore include studies designed not merely to demonstrate GRE concepts but to expose their defeat conditions. Such studies are especially important for flexible concepts such as relation, generation, value, power, field, manifestation, or participation, where confirmatory interpretation can otherwise expand with the evidence.

Definition 24.588 (GRE defeat-test protocol). A *GRE defeat-test protocol* specifies the claim under test, its operative scope, serious rival explanations, expected observations under the GRE claim and its rivals, relevant negative evidence, measurement and representation limits, local defeat conditions, escalation conditions, and the revision action to be taken if the defeat condition is met.

The protocol need not resemble one experimental falsification template. Histor-

ical counterexample research, comparative institutional analysis, mechanism tracing, replication, robustness analysis, formal equivalence tests, failed domain transfer, archival disconfirmation, and rival-theory comparison can all provide defeat-relevant evidence. What matters is that the design could rationally lower the status of the claim rather than only enrich its interpretation.

Definition 24.589 (Adversarial GRE study). An *adversarial GRE study* is a study deliberately structured to identify conditions under which a GRE explanation loses discrimination relative to a serious alternative, including conditions selected because they are expected to stress the concept rather than display it favorably.

Adversarial study design is particularly useful for cross-domain portability and historical generalization. Cases should not be selected only where relational or generative vocabulary already appears intuitively suitable. Ecological systems with strongly material constraints, legal systems with constitutive status rules, markets with near-complete commensuration, or historical episodes poorly captured by generative narratives may provide more informative stress tests than paradigmatic examples.

Definition 24.590 (Negative-result preservation record). A *negative-result preservation record* stores failed identification, non-replication, unsuccessful transfer, null mechanism evidence, incompatible formalization, adverse historical cases, and abandoned conceptual distinctions together with the scope and assumptions under which the negative result was obtained.

Negative-result preservation matters because an open programme can otherwise accumulate positive examples while repeatedly forgetting where concepts failed. The record should remain part of theoretical provenance, especially when later versions of GRE modify the relevant concept.

Proposition 24.591 (Defeat-test inclusion principle). A *mature GRE research direction* should include at least one credible design capable of lowering the warranted status of its central claim; a programme composed only of illustrative, confirmatory, or vocabulary-expanding studies is insufficiently answerable to counterevidence.

This principle does not require every individual study to be adversarial. It requires the portfolio to contain serious opportunities for defeat and revision.

24.23.5 Domain-Interface Research

Domain interfaces are not completed once a translation vocabulary has been written. They are empirical and conceptual research sites. Each interface should ask which economic claims survive receiving-domain reconstruction, which concepts change type, which imported premises remain externally warranted, which remainders resist translation, and whether the interface reveals a limitation in GRE rather than only a difference between disciplines.

Definition 24.592 (Domain-interface research agenda). A *domain-interface research agenda* is a set of paired or multi-domain inquiries designed to test translation, non-translation, reciprocal correction, constitution across domains, and the stability of GRE claims after receiving-domain reconstruction.

The agenda should include successful and failed interfaces. A successful transfer may show that a GRE distinction has wider analytical value. A failed transfer can

reveal which assumptions are specifically economic. A partially successful transfer may identify a thinner shared structure plus a substantial domain-specific remainder. None of these outcomes alone establishes a general GRT structure.

Definition 24.593 (Interface stress case). An *interface stress case* is a research case selected because economic and neighboring-domain constitutions are difficult to separate, translation loss is expected to be substantial, or competing domains assign materially different meanings or authorities to apparently shared concepts.

Examples include property relations whose legal constitution changes economic control, ecological restoration projects in which compensation and ecological regeneration diverge, educational technologies whose measured productivity and educational quality diverge, or AI-mediated institutions in which technical capability, legal responsibility, organizational authority, and economic dependence evolve at different rates. Such cases are valuable because they test whether predicate-specific jurisdiction and domain containment continue to constrain inference.

Proposition 24.594 (Interface correction-loop principle). *Domain-interface research should be designed as a correction loop in which GRE generates questions for neighboring domains, receiving-domain findings can alter GRE premises, and the revised GRE account is re-tested for economic consequence without treating either direction of translation as authoritative by default.*

The principle gives cross-domain openness an operational form. It also creates comparative material for future generalization without making cross-domain similarity a premise of the research.

24.23.6 Historical Revalidation Discipline

A research programme situated in historical time cannot assume that its concepts, measurements, institutional referents, or empirical regularities retain fixed meaning. Historical revisability applies both backward and forward. Earlier periods may require reconstructed categories that differ from present GRE terms, while future economic systems may generate new relations, value forms, AI configurations, institutional structures, or ecological constraints for which present concepts are inadequate.

Definition 24.595 (Historical revalidation task). A *historical revalidation task* examines whether a GRE claim retains its meaning, mechanism, evidential bridge, and scope when transported across a materially different historical configuration, including changed institutions, categories, technologies, ecological conditions, value forms, or manifestation regimes.

Historical revalidation differs from replication. Replication may ask whether an empirical pattern recurs under comparable conditions. Historical revalidation asks whether the object and inferential bridge remain sufficiently stable for the claim to be the same claim. A category can retain its name while changing constitution; an apparently stable institution can acquire different functions; a power mechanism can migrate from direct control to infrastructural dependence; a value form can be reclassified or generated through new technical systems.

Definition 24.596 (GRE validity horizon). A *GRE validity horizon* is the declared his-

torical and institutional range within which a claim is presently expected to retain sufficiently stable semantics, mechanism, and evidential support without renewed reconstruction.

Validity horizons can differ sharply by claim. A basic distinction between transfer and generation may have a long conceptual horizon while a claim about one AI capability stack may require rapid revalidation. A historical category may be meaningful only for a narrow institutional period. A justice claim may depend on a normative premise whose authority is explicitly contested. The horizon should therefore be attached to the claim rather than to GRE as a whole.

Definition 24.597 (Theory-expiration trigger). A *theory-expiration trigger* is a materially relevant change in the configuration on which a GRE claim depends that requires revalidation before the claim is transported further, even when no direct counterexample has yet been observed.

Triggers can include institutional redesign, category change, technological discontinuity, ecological regime change, changed data-generation processes, new legal constitution, altered human–AI division of labour, or evidence that the original manifestation relation no longer holds.

Proposition 24.598 (Historical revalidation principle). *GRE should treat transport across material historical change as a new inferential task rather than as automatic continuation of an earlier result; where a validity horizon has been crossed, revalidation should precede strong claims of persistence or generality.*

Historical revalidation also preserves theoretical memory. When a claim expires or changes type, the earlier version should remain reconstructable rather than silently rewritten in current vocabulary. This allows the history of GRE itself to become evidence about how theory changes with its objects.

24.23.7 Future-Theory Formation

An open programme should permit new theory to arise from unresolved problems without treating every recurring pattern as a new foundational layer. Future theory can emerge through repeated empirical regularities, failed transfers, unresolved remainders, new formal distinctions, newly observable mechanisms, or persistent anomalies in the present architecture. The evidential threshold should rise with the scope of the proposed theory.

Definition 24.599 (Future-theory candidate). A *future-theory candidate* is a proposed concept, mechanism, formal structure, or architectural revision generated by recurrent limitation-derived evidence and specified with its source problems, domain of support, rival formulations, non-supporting cases, evidential status, and expected consequences for existing GRE claims.

A candidate should not become part of GRE merely because it is elegant or integrates many terms. A new formalism may be useful only schematically. A recurring cross-domain pattern may arise from shared conceptual ancestry. A new value form may be a context-specific subtype rather than a general category. A new power mechanism may belong to a neighboring domain. The candidate stage therefore protects both innovation and restraint.

Definition 24.600 (Theory-promotion dossier). A *theory-promotion dossier* records the evidence required to move a future-theory candidate into a stronger programme status, including independent supporting cases, failed-case analysis, semantic stability, historical variation, empirical discrimination, formal necessity where relevant, domain corrections, and the claims that would change if the candidate were accepted.

Promotion need not be binary. A candidate can remain a heuristic, become a domain-specific hypothesis, become a structural formalization, acquire empirically parameterized support, or be incorporated as a revisable conceptual distinction. This preserves the claim-status discipline developed throughout the book.

Definition 24.601 (Theory retirement condition). A *theory retirement condition* is reached when a GRE concept or model repeatedly fails its declared discriminating tasks, is superseded by a clearer formulation, or no longer contributes enough explanatory, empirical, or practical value to justify maintaining it as active programme infrastructure.

Retirement is compatible with preservation. A retired concept can remain historically important, pedagogically useful, or locally adequate. The point is to avoid treating theoretical accumulation as one-way expansion.

Proposition 24.602 (Future-theory proportionality principle). *The evidential burden for a future GRE theory should increase with the breadth of the claim it reorganizes: local concepts can be supported locally, while claims that alter core vocabulary, architecture, domain boundaries, or candidate GRT structures require correspondingly broader independent comparison and counterevidence testing.*

This principle permits theoretical creativity while resisting premature unification. It also supplies a bridge to Chapter 25, which considers the programme identity capable of surviving plural formulations and future revision.

24.23.8 Integrated Limitation-Derived Programme

Chapter 24's limitation record can be synthesized as an architecture of dependencies among claims, tests, domains, histories, methods, and revision pathways. An open programme should distinguish what is established, provisional, outside present authority, or defeated, and should make visible how a change in one status propagates elsewhere.

Definition 24.603 (Integrated GRE limitation-derived programme). The *integrated GRE limitation-derived programme* is the coordinated portfolio of scope conditions, discriminating questions, research-direction packets, collaboration interfaces, defeat tests, negative-result records, domain-interface agendas, historical revalidation tasks, and future-theory dossiers attached to consequential GRE claim families.

Coordination matters because one finding can affect several layers. An archival source can revise a reconstruction and thereby change a conversion claim; a legal reinterpretation can retype an institution and alter a power analysis; a failed replication can weaken one mechanism without defeating the broader distinction. The programme should therefore represent dependencies rather than count findings as independent units.

Definition 24.604 (GRE programme dependency map). A *GRE programme depen-*

dependency map records which claims depend on which conceptual distinctions, external premises, empirical identifications, historical bridges, value classifications, formal representations, and normative commitments, together with the revision pathways activated when one dependency changes status.

The map supports selective revision: local counterevidence need not become total framework failure, while a foundational defeat should not be isolated artificially when many downstream claims depend on it. The surrounding research portfolio should also include constructive, comparative, adversarial, replication, historical, formal, cross-domain, negative-result, and revision-oriented work so that one method or evidential direction does not become self-reinforcing.

Proposition 24.605 (Scope-conditioned research principle). *Every consequential GRE extension should carry an explicit scope discipline stating what the study seeks to establish, what it does not establish, what could defeat or revise it, which external warrants it depends on, and how a sustained result would alter the programme.*

Scope conditions are therefore part of research design rather than barriers added afterward. They help distinguish discovery from semantic expansion, successful transfer from domain overreach, formal insight from ontological escalation, and practical usefulness from normative authority.

Definition 24.606 (Constructive incompleteness). *Constructive incompleteness is a programme condition in which unresolved questions, non-claims, failed transfers, negative results, rival theories, and known limits remain explicit resources for inquiry rather than being concealed by premature closure.*

Constructive incompleteness is constrained by the defeat and revision disciplines of Sections 24.21 and 24.22. Openness without defeat conditions becomes insulation; defeat conditions without openness can freeze the programme around present formulations.

Proposition 24.607 (Chapter 24 open-limit principle). *Present GRE limits should function simultaneously as boundaries on current claims and as structured invitations to research: a limitation may justify a non-claim, generate a discriminating question, organize collaboration, specify counterevidence, and later become a site of conceptual or architectural revision.*

Chapter 24 therefore closes with a bounded claim. GRE becomes more answerable when its limits are typed, failures preserved, counterevidence propagated, and future extensions conditioned on renewed evidence and domain correction. Chapter 25 can now ask the wider closing question: what kind of open programme can remain recognizably GRE while permitting plural formulations, contestation, historical re-epistemization, and revision of the concepts through which the programme presently understands itself?

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