Chapter 14

Generative Value

Value Architecture and Chapter Scope

Chapter 14 develops generative value as the third substantive layer of Part V. Chapter 12 established a relational architecture for economic systems, and Chapter 13 examined allocation as a relational intervention within that architecture. The present chapter asks how economic significance is generated, manifested, transmitted, converted, recirculated, accumulated, diminished, measured, historically revised, and returned through those processes. Its role is therefore broader than proposing an alternative theory of price or exchange value. Possession, exchange, and monetary representation remain important economic interfaces, while GRE adds analytical resolution when capabilities, relations, knowledge, institutions, participation, future options, ecological conditions, historical dependence, or heterogeneous forms of value materially affect the inquiry.

The chapter has four principal objectives. First, it develops a plural and ontologically restrained vocabulary of value. Material, financial, capability, relational, epistemic, institutional, participatory, option, future, and ecological value are treated as overlapping analytical forms rather than mutually exclusive substances. Their relevance depends on the subject or collective involved, the evaluative standpoint, the historical horizon, and the relations and institutions through which value becomes practically realizable. The chapter therefore distinguishes value-bearing conditions from their manifestations, symbols, prices, indicators, and other representations. A useful representation can be precise and operational without exhausting the value that it represents.

Second, the chapter reconstructs value through differentiated processes. Generation concerns the emergence or expansion of value-bearing conditions; transmission and transfer concern passage across positions and channels; propagation concerns widening reach; conversion concerns transformation across value forms or practical registers; recirculation concerns re-entry into later generative processes; accumulation concerns historically cumulative increase; concentration concerns distribution of control, access, or realization; dissipation concerns loss of usable organization or availability; extraction concerns asymmetric appropriation tied to source-side loss; and generative return concerns value-bearing effects that re-enter later processes as conditions of further generation, maintenance, coordination, adaptation, or transfor-

mation. These distinctions prevent the language of "value creation" from compressing several different mechanisms into one undifferentiated claim.

Third, the chapter preserves adverse, plural, and contested value phenomena within the same analytical architecture. Economic processes can generate harm, capacity loss, relational erosion, institutional damage, option foreclosure, ecological depletion, or long-horizon burdens. Multiple value orders can coexist without being fully commensurable, and conflict among them need not be resolved through universal monetization or aggregation. GRE therefore distinguishes comparison from commensuration and translation from equivalence. Decisions can use thresholds, partial rankings, lexicographic priorities, deliberation, safeguards, or other plural architectures while preserving unresolved evaluative remainder. Negative value and harm remain historically and standpoint dependent rather than being treated as simple negative entries on a universal value scale.

Fourth, the chapter develops a cautious account of valuation, measurement, history, and future return. Indicators, proxies, prices, accounting treatments, capability measures, relational measures, epistemic measures, and option-space measures are measurement representations whose adequacy depends on purpose and provenance. Measurement systems can become performative when they organize funding, eligibility, reputation, or institutional action. Historical change can transform scarcity, productive conditions, institutions, subject positions, value forms, valuation regimes, and epistemic standing. Later evidence can re-epistemize earlier value judgments without pretending that earlier actors possessed knowledge available only in retrospect. Generative return then asks what generated conditions become usable again in later processes, through which pathways, for which positions, across what horizon, and with what uncertainty.

The analytical stance throughout is process-sensitive and scope disciplined. A narrow market question can often be answered adequately through price, quantity, or accounting measures. A capability problem can require attention to conversion conditions and effective opportunity. A relational or institutional problem can require reconstruction of trust, authority, legitimacy, maintenance, or access. A long-horizon ecological or intergenerational question can require several value forms and historical scales at once. GRE therefore does not require maximal value plurality for every problem. It asks researchers to increase analytical resolution when omitted value forms, pathways, positions, or historical effects would materially change the claim being made.

Ontological suspension remains equally important. The chapter does not claim that value is ultimately a substance, vector, field, relation, flow, trajectory, or operator. Each representation has a domain of adequacy. Typed spaces are used to preserve heterogeneity across value forms; transmission and conversion operators represent structured transformations when such formalization clarifies the inquiry; tables and taxonomies organize distinctions without fixing an exhaustive ontology. Generativity itself is descriptive before it is normative. A process can generate capability, dependency, exclusion, ecological depletion, surveillance, institutional rigidity, or new options. A claim that something is generative therefore requires a separate evaluative argument before it can be treated as desirable.

The internal organization follows the movement from value concept to value

process and then to historical-spatiotemporal integration. Section 14.1 establishes the problem of value in GRE, and Section 14.2 differentiates major value forms. Section 14.3 develops relational emergence, manifestation, symbolization, and ontological restraint. Section 14.4 analyzes pathways of value generation. Section 14.5 distinguishes transmission, transfer, and propagation, while Section 14.6 develops value conversion across heterogeneous forms. Section 14.7 treats recirculation, and Section 14.8 distinguishes accumulation from concentration. Section 14.9 analyzes dissipation, leakage, extraction, dependency, and depletion, followed by Section 14.10's treatment of negative value and harm. Section 14.11 develops plurality and incommensurability, and Section 14.12 addresses valuation and measurement. Section 14.13 develops generative return, Section 14.14 historicizes transformation of value and its epistemic reconstruction, and Section 14.15 closes the chapter by locating these value processes within a bounded interface to generative spacetime.

The chapter's closing movement is deliberate. Once value is represented through trajectories of generation, conversion, propagation, recirculation, accumulation, delay, and historical transformation, static state descriptions can become insufficient for some problems. The next chapter therefore develops the spatiotemporal grammar required to represent events, processes, trajectories, heterogeneous presents, relational distance, reachability, sequence, path dependence, delayed generation, spatial propagation, structural transformation, and multiscale historical organization. Chapter 14 supplies the value-process architecture; Chapter 15 asks how those processes are situated in generative spacetime.

14.1 The Problem of Value in GRE

Chapter 13 established that allocation can alter capacities, relations, institutions, dependencies, option spaces, and later conditions of generation. The role of this opening section is to specify the corresponding problem of value before Chapter 14 differentiates particular value forms and processes. Its objective is to clarify what GRE needs from a theory of value, which familiar value interfaces remain useful, and which additional distinctions become necessary once value is examined relationally, generatively, historically, and under conditions of plurality. The method is conceptual and reconstructive. It draws selectively on economic, philosophical, and sociological value traditions while preserving ontological suspension and avoiding a premature synthesis among theories whose objects and normative commitments differ.

The term *value* enters economic analysis through several partially overlapping questions. An analyst can ask what an asset is worth in exchange, which goods or states persons prefer, what contributes to welfare, which capacities or freedoms matter, how an institution recognizes or prices an object, why a community protects a relation or practice, or how a resource participates in the generation of later possibilities. These questions can sometimes be represented through a common monetary measure, while in other cases the translation itself becomes part of the object of inquiry. A GRE account therefore requires enough breadth to follow heterogeneous value processes without treating every economically relevant form of value as one latent substance awaiting measurement.

This breadth does not displace possession, exchange, price, preference, utility, or accounting. Each can be an adequate representation for a suitably bounded question. The difficulty arises when a representation that is adequate for one interface is extended to effects that operate through another. A market price can record an exchange relation while leaving unrepresented an institutional capacity created during production. Ownership can identify a legally protected control position while leaving collective maintenance relations outside the asset boundary. A project can generate knowledge that is weakly appropriable by the funder yet highly consequential for later research. An ecological condition can support productive activity over long horizons while appearing only indirectly in transaction records. GRE treats such cases as reasons for analytic differentiation rather than as evidence that conventional economic representations are intrinsically mistaken.

The present chapter therefore begins with a restrained proposition: value analysis should preserve the distinctions that matter to the research question. Where possession and exchange capture the relevant incidence, additional relational machinery adds little. Where value depends materially on conversion conditions, relations, institutions, histories, future options, or generative processes, those conditions become part of the value analysis. This principle parallels the scope discipline developed for allocation in Chapter 13.

The framework also separates *generation* from *valuation*. A process can generate new outputs, relations, dependencies, harms, or opportunities without thereby establishing their desirability. Conversely, something can be treated as valuable because it preserves an existing capacity, relation, ecological condition, or option rather than because it produces a novel output. Generativity is therefore descriptive before it becomes evaluative. The normative standing of a generated effect depends on a value claim, its standpoint, its affected subjects, its horizon, and the competing values or burdens relevant to the case.

Definition 14.1 provides a deliberately modest analytical starting point. It defines a value attribution rather than the ultimate nature of value.

Definition 14.1 (Situated value attribution)**.** Within GRE, a *situated value attribution* is an analytically identified recognition that an object, condition, capability, relation, institution, process, or possible trajectory carries positive, negative, or mixed economic significance relative to one or more subjects, collectives, evaluative frameworks, and historical horizons.

The definition is indexed because value claims can diverge across positions. A relation that provides security to one participant can impose dependence on another. A technical standard can create interoperability for established firms while raising entry costs for smaller organizations. A wetland can be valued as developable land, flood protection, habitat, cultural landscape, or a condition of ecological continuity. These valuations can interact without becoming identical. Sociological research on valuation emphasizes that evaluation is organized through practices of categorization, legitimation, comparison, and institutional judgment rather than arising only as an isolated private preference (Lamont 2012). Work on commensuration similarly shows that creating a common metric is itself a consequential social operation, especially when heterogeneous entities are rendered comparable (Espeland and Stevens 1998). GRE uses these insights to keep valuation procedures visible when they mate-

Table 14.1: Analytical dimensions of the value problem in GRE

Dimension	Primary analytical object	Characteristic question	Scope restraint
Possession	Holding, control, use, exclusion, and claim positions	What valued object or capacity is controlled, by whom, and through which rights?	Legal or practical possession need not exhaust value incidence
Exchange	Transfer, price, willingness to trade, and exchange ratio	Which value becomes expressed through exchange and under which market or institutional conditions?	Exchange representation need not capture nontraded or weakly tradable value
Relation	Position-dependent and relation-mediated significance	How does value depend on relations among subjects, institutions, objects, and environments?	Relational dependence does not imply that value is reducible to interpersonal relations
Generation	Production of later capacities, relations, options, and conditions	Which processes create, preserve, or regenerate economically significant possibilities?	Generation does not establish normative desirability by itself
History	Path, sequence, inherited conditions, and changing context	How do scarcity, institutions, technology, subject positions, and prior events alter value?	Historical dependence does not imply unrestricted relativism
Plurality	Heterogeneous value forms and evaluative orders	Which values coexist, conflict, translate, or resist common measurement?	Plurality does not preclude local comparison or justified aggregation
Ontological restraint	Status of value concepts and representations	What does the analysis need to assume about value in order to answer the local question?	Useful models do not by themselves establish the ultimate ontology of value

rially shape the economic process.

Table 14.1 summarizes the seven dimensions developed in this section. They should be read as analytical coordinates rather than as a hierarchy or complete ontology of value.

14.1.1 Value and Possession

Possession is one of the most important interfaces through which economic value becomes institutionally visible. Ownership, custody, use rights, claims, entitlements, and control over productive assets can determine who may use a resource, exclude others, transfer it, pledge it, derive income from it, or decide its future disposition. For many questions, possession is therefore an appropriate analytical starting point. Asset accounts, household wealth measures, property registries, inventories, and organizational balance sheets all rely on boundaries that connect valued objects to identifiable holders or claimants.

GRE retains these representations while separating possession from the full incidence of value. The first reason is that the value realized through possession depends on conversion conditions. Two subjects can formally possess equivalent resources while facing different capacities to use them, maintain them, combine them with complementary resources, or convert them into recognized opportunities. The capability tradition provides a prominent precedent for distinguishing resources from what persons are substantively able to do with them (Sen 1999). Chapter 13 used the same discipline for allocation. Chapter 14 generalizes the implication for value: a possessed object can have different practical significance across relational and institutional positions.

A second reason is that some economically consequential value is distributed

across arrangements whose boundaries do not coincide with ownership. Shared infrastructure illustrates the point. A transport network can be publicly owned, privately operated, financed through several institutions, maintained by specialized contractors, and used by actors who own none of the physical system. Its value for a particular user can depend on network coverage, schedule reliability, interoperability, accessibility, and connection to other activities. Possession remains relevant, especially for control and accountability, while the realized value is partly relational and infrastructural.

Knowledge provides another case. A laboratory can own equipment and hold formal rights in a dataset while the practical value of the research environment also depends on tacit expertise, mentorship, collaboration, reputation, standards, and access to external scientific communities. These elements can be unequally distributed even where formal ownership is clear. The same distinction applies to organizations. A firm may own machinery, patents, or databases while depending on employees, suppliers, technical standards, legal institutions, public infrastructure, and accumulated knowledge that cannot be represented adequately as assets held exclusively by the firm.

Possession can also be relationally constituted through law and institution. What counts as an ownable object, which incidents of ownership are recognized, and how claims are enforced vary historically. This observation does not erase the practical force of property rights. It indicates that possession is an institutionally stabilized relation among actors, objects, and authorities rather than a context-free physical fact. The corresponding GRE question concerns how possession structures access, control, exclusion, responsibility, and later generative possibility.

Possession is therefore best treated as one value interface among several. It is especially informative when control, security of claim, alienability, collateralization, or exclusion are central to the research question. Its limits become analytically important when the relevant value arises through shared use, collective maintenance, distributed knowledge, relational complementarity, ecological dependence, public infrastructure, or future option generation. In those cases, possession analysis remains part of the account while broader incidence must be reconstructed separately.

14.1.2 Value and Exchange

Exchange provides a second major interface through which value becomes economically legible. Prices, exchange ratios, bids, contracts, and observed trades can condense dispersed judgments and constraints into comparable quantities. Classical and neoclassical political economy developed different accounts of value, production, distribution, demand, and exchange, while later economic analysis made market valuation and marginal adjustment central to many domains (Ricardo 1817; Marx 1867; Marshall 1890). GRE does not require a single reconciliation of these traditions in order to make a narrower methodological point: exchange reveals an important dimension of value, and the conditions of exchange shape what that dimension means.

An observed price records a realized exchange under particular institutional, informational, bargaining, temporal, and distributional conditions. It can be highly informative about opportunity cost, scarcity, willingness to pay, expectations, or mar-

ket structure, depending on the model and evidence. The same price does not automatically report every value relevant to the participating subjects or affected third parties. A transaction can occur under urgency, unequal bargaining power, liquidity constraints, incomplete information, regulated terms, strategic behavior, or external effects. Exchange value is therefore a situated economic representation whose interpretation depends on the process that generated it.

Some values also enter economic life without passing through ordinary exchange. Household care, open knowledge, public infrastructure, ecological services, volunteer activity, institutional trust, and many forms of social coordination can have substantial economic consequence even when no direct market transaction assigns them a price. Their absence from exchange records does not by itself establish either high or low value. It means that exchange data answer a narrower question than the broader value inquiry.

The inverse problem also matters: monetization can make previously weakly commensurable objects comparable for a specific decision. Commensuration may improve transparency, enable budgeting, or support trade-offs, while simultaneously changing how the object is perceived and governed. Espeland and Stevens analyze commensuration as a social process with cognitive and political consequences (Espeland and Stevens 1998). Fourcade's study of environmental valuation similarly shows that monetary valuation involves institutionally organized techniques and can feed back into social understandings of the valued object (Fourcade 2011). For GRE, the implication is that valuation interfaces can participate in the relational world they measure.

Exchange can also convert among value forms. A credential can increase access to employment; reputation can support financing; data can be exchanged for service access; ecological degradation can be translated into compensation; a patent can convert knowledge into an exclusion right and a revenue stream. These conversions can be partial and contested. The price realized at one interface does not necessarily preserve the full value attributed at another interface, and the conversion may redistribute control over the generative conditions from which the value emerged.

The appropriate conclusion is analytic rather than anti-market. Exchange is often indispensable to value analysis. GRE asks when exchange is the focal value relation, which institutions and asymmetries condition it, what remains outside the exchange boundary, and whether the exchange changes later capacities, relations, or option spaces. This permits prices and markets to remain powerful analytical tools without requiring them to serve as universal translations of every value form developed later in this chapter.

14.1.3 Value and Relation

A relational account begins from the observation that economic significance often depends on position within a configuration rather than on an isolated object alone. The same resource can carry different value when complementary relations, institutional recognition, social meanings, technical interfaces, or ecological conditions differ. A license has value where it is legally recognized; a language skill has greater practical significance where interaction partners and institutions use that language;

a technical standard becomes consequential through compatible adoption; trust can reduce coordination costs only within relations in which expectations and vulnerability matter. The object and its relations jointly shape realized significance.

GRE uses *relational value* in a broad analytical sense that should be distinguished from narrower established uses of the term. Environmental scholarship, for example, has developed a specific category of relational values concerning relationships, responsibilities, and forms of living well in relation to nature (Chan et al. 2016). That literature provides an important substantive example, but GRE does not treat every relation-dependent value as equivalent to that category. The present framework needs a more general vocabulary capable of describing value that depends materially on relational position across economic, institutional, epistemic, technical, ecological, and social settings.

Relation dependence can enter value analysis in at least four ways. First, relations can be *conditions of realization*. A resource becomes usable only through access to complementary actors, infrastructure, rights, or knowledge. Second, relations can be *objects of valuation*. Trust, care, collaboration, autonomy, recognition, reciprocity, and institutional legitimacy can themselves be treated as valuable or harmful. Third, relations can be *channels of propagation*. Value generated at one position can reach others through supply chains, networks, public institutions, households, or ecological systems. Fourth, relations can structure *control over conversion*. A subject may possess a resource while another actor controls the interface through which that resource becomes income, mobility, recognition, or participation.

This relationalization should not be mistaken for a claim that value exists only between persons. Relations can connect persons, organizations, institutions, technologies, resources, places, ecological systems, legal statuses, symbols, and forms of knowledge. Nor does relational dependence eliminate properties of the objects involved. A medicine's biochemical properties, a bridge's structural integrity, or a computer's processing capacity matter materially. GRE's point is that the economically realized significance of such properties can depend on how they enter wider configurations.

Relational analysis also helps explain distributed value incidence. A new rail station can raise accessibility for nearby residents, alter land values, shift commercial activity, change commuting patterns, and impose construction or displacement burdens on others. Asking only who owns the station or who purchases a ticket would miss part of the relevant value landscape. The same principle applies at smaller scales. Training one employee can improve individual capability while also changing team coordination, mentoring capacity, bargaining position, or organizational dependence.

The concept of relation therefore performs a bounded role. It identifies dependencies, pathways, positions, and jointly constituted conditions that materially affect value. It does not imply that every possible relation must be included. The research question should determine which relations enter the analytical boundary. This keeps relational value analysis compatible with tractable empirical work and avoids turning relationality into an unlimited demand to model the entire social world.

14.1.4 Value and Generation

Generation shifts attention from the current location of value toward the processes through which later value-bearing conditions arise. Chapter 13 introduced this movement through allocation-mediated value trajectories. A grant can become training, data, infrastructure, organizational credibility, or further research capacity; a transport investment can alter accessibility and later land-use possibilities; a cooperative reserve can stabilize production and preserve future bargaining capacity. In each case the value question concerns more than the transferred resource. It concerns what the surrounding process is able to create, preserve, regenerate, or foreclose.

GRE's use of generative value is explicitly indebted to the generative-justice tradition. Eglash develops generative justice around value generation, participation by value generators, and circulation that returns value toward the people, communities, and conditions that produce it (Eglash 2016). Later work further emphasizes unalienated circular value flows and the restoration of generative conditions across human and non-human communities (Eglash et al. 2024). GRE draws on this lineage while broadening the analytical questions around heterogeneous value forms, conversion interfaces, propagation, dissipation, capture, multiscale incidence, and historical trajectories.

The generative perspective introduces several distinctions. *Produced output* and *generative capacity* are related but different. A process can yield a large current output while degrading the ecological, technical, relational, or institutional conditions needed for future production. Conversely, an investment can have modest immediate output while building skills, standards, trust, or infrastructure that supports later activity. *Novelty* and *generation* also differ. Maintaining a public health system, archive, irrigation network, or ecological condition can preserve the capacity for future action without producing an obviously novel object. Maintenance and regeneration therefore belong within the generative analysis when they materially sustain future valued possibilities.

Generation can also be recursively structured. Knowledge produced in one project can become an input into another; institutional credibility can attract new partners; infrastructure can support unforeseen downstream uses; learning can improve later learning. These processes motivate the later chapters' attention to recirculation, accumulation, and generative return. They also create risks of recursive disadvantage. Dependency, ecological depletion, exclusion, and capability loss can reproduce conditions that constrain subsequent generation. The analytical symmetry matters: generative processes can expand or contract later possibilities.

For this reason, GRE preserves the distinction between *generativity* and *generative value*. Generativity describes a capacity or process that materially affects what can be generated later. Generative value introduces an evaluative claim concerning which of those generated capacities, relations, or possibilities count as valuable under a specified standpoint. A highly productive surveillance system, for example, can generate information and institutional capacity while also generating harms, asymmetries, and constraints. Its generativity does not settle its value.

The generative perspective therefore changes the temporal unit of value analysis. Immediate outcomes remain important, but some value becomes visible only through

later trajectories, conversion opportunities, or sustained capacities. This does not authorize unlimited speculation about remote futures. Claims about generative value should identify the mechanism, horizon, affected subjects, and uncertainty that connect present conditions to later possibilities. Generativity earns analytical weight through a traceable process rather than through rhetorical appeal to the future.

14.1.5 Value and History

Value is historically situated because the conditions under which objects, relations, and capabilities become economically significant change. Scarcity changes; productive forces change; institutions change; technologies create new complements and dependencies; legal categories alter recognized claims; social meanings shift; infrastructures expand or decay; and the positions from which subjects can convert resources into opportunities are transformed. Historical variation therefore affects both what can be valued and how valuation becomes practically operative.

The historical point is stronger than the observation that prices fluctuate. A technological change can alter the value of previously specialized skills. A regulatory change can turn an informal practice into a licensed activity or make a formerly tradable asset nontransferable. A scientific discovery can create value in data collected for another purpose. A new transportation link can change the economic significance of location. A political or institutional transition can alter whose knowledge is recognized, which claims are enforceable, and which relations are considered legitimate. These are transformations of the conditions of valuation, not merely changes in a scalar amount attached to an otherwise fixed object.

Economic history and institutional analysis provide many precedents for treating economic categories as historically constituted. Polanyi's account of market society emphasizes historical reorganization in the relation between economy and society (Polanyi 1944). Marx's analysis of capital likewise situates value processes within historically specific relations of production, labor, and accumulation (Marx 1867). GRE does not collapse these traditions into one historical theory. It takes from them a methodological caution: value concepts can carry assumptions tied to particular institutional and productive arrangements.

Historical situatedness also affects retrospective evaluation. An allocation or institution may have been reasonable under information and constraints available at one time while later evidence reveals burdens or alternatives that were previously weakly visible. Conversely, retrospective analysts can mistakenly project current categories backward and treat past actors as if they possessed present knowledge or institutional possibilities. Chapter 13 distinguished allocation-time, implementation-time, and later-evaluation positions. Value analysis requires the same provenance discipline.

A further implication concerns historical generation of evaluative standards. Valuation does not occur only after economic processes have produced neutral objects. Institutions, professions, markets, scientific practices, political struggles, and cultural classifications can shape which properties become salient and which metrics gain authority. Dewey's pragmatist theory of valuation treats valuation as situated activity involving desires, ends, appraisal, and consequences rather than as the passive dis-

covery of fixed value properties (Dewey 1939). Sociological work likewise studies valuation as organized practice (Lamont 2012). These traditions differ in purpose, but both support attention to the processes through which value becomes articulated and stabilized.

Historical dependence does not imply that every value claim is equally warranted. Evidence, argument, institutional purpose, affected interests, and ethical reasoning can still support criticism and comparison. The point is narrower: value judgments and measurements have histories, and those histories can matter to their interpretation. GRE therefore treats historical reconstruction as one possible component of value analysis when present categories or distributions cannot be understood adequately without their generative path.

14.1.6 Value Plurality

The preceding dimensions make value plurality difficult to avoid. Economic processes can generate material output, income, capability, knowledge, trust, institutional capacity, ecological resilience, participation, security, status, time, autonomy, and future options. Some of these can be represented monetarily for particular purposes; others are only partially captured by monetary measures; still others may be treated by affected subjects as inappropriate to translate into a single common metric. GRE therefore begins from the possibility of heterogeneous value forms rather than assuming commensurability in advance.

Value plurality has at least three levels. The first is *plurality of objects*: different things are valued. The second is *plurality of modes of valuation*: the same object can be valued as a market asset, a capability, a relation, a public institution, an ecological condition, or a cultural inheritance. The third is *plurality of evaluative standpoints*: subjects and collectives can disagree about which consequences matter, which obligations apply, or which trade-offs are acceptable. These levels can overlap without being identical.

Anderson's work on value in ethics and economics provides an influential defense of plural modes of valuation and criticism of reducing heterogeneous goods to one market or cost-benefit metric (Anderson 1993). Korsgaard's distinction between intrinsic/extrinsic and final/instrumental value similarly cautions against collapsing different evaluative distinctions into a single axis (Korsgaard 1983). GRE uses such distinctions as reminders that labels like "instrumental," "intrinsic," "market," or "social" answer different questions and should not be treated as interchangeable partitions of one universal value taxonomy.

Plurality does not eliminate comparison. Institutions routinely compare heterogeneous considerations when allocating budgets, setting safety standards, choosing infrastructure, evaluating research, or adjudicating rights. The analytical task is to make the translation rule visible. Monetary valuation, multicriteria evaluation, legal priority rules, threshold standards, deliberative procedures, qualitative judgment, and negotiated compromise are different ways of structuring comparison. Each can be appropriate under some conditions, and each can suppress information that another method would preserve.

Commensuration is therefore an operation that requires justification rather than

a background assumption. A common unit can reduce complexity and enable coordination. It can also conceal distributional differences or convert contested values into apparently neutral quantities. The later sections on plurality, incommensurability, and measurement will examine these issues in detail. At the present stage, the key commitment is to preserve the provenance of a conversion: which values were translated, through which metric or institution, with which losses, and for which decision.

Plurality also affects generative value. A process can generate several value forms at once and distribute them differently. A university can generate credentials, knowledge, networks, local economic activity, public research capacity, and status distinctions. A renewable-energy project can generate electricity, local employment, technical capability, land-use conflict, ecological effects, and infrastructure. Describing one of these as the project's "value" without specifying the evaluative frame can obscure the coexistence of gains, burdens, and contested priorities.

GRE therefore treats value profiles as potentially multidimensional. Aggregation remains available when the research question and normative framework justify it. Disaggregation remains necessary when conversion would erase distinctions materially relevant to explanation, distribution, justice, or future generative capacity. This combination of local aggregation and principled plurality is more useful than a categorical rule either for or against common measurement.

14.1.7 Ontological Restraint about Value

The final problem is ontological. Value can be modeled as preference, utility, price, welfare contribution, capability, institutional recognition, socially organized valuation, intrinsic worth, relational significance, or generative potential. These vocabularies often belong to different theoretical projects. A GRE framework that simply declares them manifestations of one deeper entity would resolve disagreement by stipulation. Ontological suspension requires a more modest approach.

The present chapter therefore treats value concepts as analytically situated representations whose adequacy depends on the question. A price can be a real institutional fact without being an exhaustive measure of every value affected by the transaction. A capability can be substantively important without implying that capability is the sole ontological substance of value. A relational-value description can identify dependence on relationships without requiring every value to be relational in the same sense. A generative-value account can trace future capacity while leaving open whether value should ultimately be understood as a property, relation, practice, judgment, norm, or some combination of these.

This restraint is compatible with substantive argument. Moore's classical analysis of intrinsic value, Dewey's pragmatist account of valuation, Sen's connection between ethics and economics, Anderson's pluralist approach, and sociological studies of valuation each provide different reasons to resist overly narrow value reduction (Moore 1903; Dewey 1939; Sen 1987; Anderson 1993; Lamont 2012). GRE can learn from these traditions while preserving their disagreements. A relational translation between them does not establish theoretical equivalence.

Ontological restraint is especially important where formalism is introduced. A vector of value indicators can be a useful representation of several dimensions. A net-

work model can represent the propagation of a valued capacity. An operator can represent conversion between value forms. A state-space model can represent changes in available possibilities. None of these formal devices establishes that value literally exists as a vector, flow, field, operator, or coordinate. Formalism earns its place by clarifying a question, making assumptions visible, or supporting empirical inference.

The same restraint applies to negative value. Harm, depletion, burden, risk, exclusion, and constraint can be represented as negative entries in some models, but this does not imply that every harm is meaningfully the algebraic inverse of a positive value. Loss of trust may be difficult to offset by an unrelated monetary gain; ecological damage may be partly irreversible; capability loss can alter the subject's ability to benefit from later compensation. Later sections will therefore treat harm and incommensurability directly rather than assuming that one scalar sign convention resolves them.

Ontological restraint also protects the chapter from a second form of reduction: treating valuation as merely subjective. Situated value attributions can be contested, institutionally stabilized, empirically informed, ethically argued, legally recognized, or collectively negotiated. Some claims can be mistaken about consequences; some can rest on exclusionary institutions; some can be revised through evidence or deliberation. Acknowledging the standpoint of valuation therefore does not make evidence and reasoning irrelevant.

Proposition 14.2 states the scope principle that closes the section.

Proposition 14.2 (Value-analytic adequacy)**.** *For a GRE inquiry, a value representation is analytically adequate only relative to the effects that the inquiry treats as materially relevant. When possession, exchange, relational dependence, generative consequences, historical conditions, or heterogeneous evaluative standpoints materially affect the phenomenon under study, a representation that omits those identified dimensions cannot by itself recover the corresponding value incidence.*

Proposition 14.2 is a scope claim rather than a demand for maximal complexity. Many economic questions can be answered well with a price, an asset measure, a cost, a preference ordering, or another deliberately narrow representation. GRE asks the analyst to widen the frame when omitted value processes are materially relevant to explanation or evaluation. This disciplined pluralism establishes the starting point for the next section, which differentiates the principal value forms used throughout the remainder of the chapter.

14.2 Forms of Value

Section 14.1 established that GRE can require more than one value interface when possession, exchange, relations, historical conditions, or generative consequences materially affect the question under study. The role of the present section is to differentiate a set of recurring value forms that can be used throughout the remainder of Chapter 14. Its objective is classificatory rather than ontological: to identify analytically useful ways in which economic significance can be realized, recognized, organized, transmitted, or evaluated, while preserving overlap, conversion, and partial incommensurability among them. The discussion proceeds through material, finan-

cial, capability, relational, epistemic, institutional, participatory, option, future, and ecological value. The method is conceptual and comparative, drawing selectively on established economic and social-scientific traditions where they clarify a form without treating the resulting taxonomy as exhaustive.

A value form, in the sense used here, is neither a substance nor a mutually exclusive class of objects. The same object can participate in several forms of value at once. A community laboratory, for example, has material value as equipment and usable space, financial value as an asset and budgetary commitment, capability value through the activities it enables, epistemic value through the knowledge it helps produce, relational value through collaborations it sustains, institutional value when embedded in stable governance arrangements, participatory value when communities can shape its agenda, option value when it preserves future research possibilities, future value when benefits arise over a long horizon, and ecological value when its operation or design affects environmental conditions. The analytical task is therefore to identify which value dimensions are materially relevant to the inquiry and how they interact.

Definition 14.3 fixes the term in this limited sense.

Definition 14.3 (Value form)**.** Within GRE, a *value form* is a recurring analytical mode through which economic significance is realized, recognized, organized, transmitted, or evaluated with respect to particular objects, capabilities, relations, institutions, processes, or possible trajectories. A value form identifies a mode of significance and its characteristic realization conditions; it does not imply an independent value substance, mutual exclusivity from other forms, or automatic commensurability with them.

This definition allows two kinds of overlap that matter for later analysis. First, a single bearer can instantiate several value forms. Financial resources can finance capability formation; an institution can embody knowledge; a relation can provide access to material infrastructure. Second, one form can be converted into another through historically and institutionally specific processes. Education funding can become capability value only through educational institutions, time, teaching, access, and learning. Scientific knowledge can become financial value through intellectual-property arrangements, commercialization, or productivity effects. Ecological conditions can become monetized through markets or administrative valuation, while retaining significance that is not exhausted by the resulting price. Conversion therefore requires analysis of the relevant interface rather than an assumption that the forms are already equivalent.

Table 14.2 summarizes the ten forms developed below. The table is a working analytical map. Particular inquiries can require additional distinctions, combine several rows, or use narrower domain-specific categories.

14.2.1 Material Value

Material value concerns the economic significance carried by physical resources, artifacts, infrastructures, energy, land, biological materials, and other embodied conditions that participate in production, use, maintenance, or reproduction. The category is deliberately broader than commodity value. A material object can be eco-

Table 14.2: Analytical forms of value used in GRE

Form	**Primary analytical focus**	**Characteristic realization conditions**	**Characteristic reduction risk**
Material	Physical resources, artifacts, embodied conditions, and usable stocks	Availability, quality, location, maintenance, compatibility, and practical access	Equating physical possession with realized use
Financial	Money-denominated assets, claims, liquidity, purchasing power, and financing capacity	Monetary institutions, enforceable claims, convertibility, market access, and confidence	Treating monetary expression as a complete value measure
Capability	Effective capacities to act, function, produce, participate, or convert resources	Skills, health, knowledge, complementary resources, institutions, and conversion factors	Inferring capability directly from resource possession
Relational	Significance carried by or realized through relations and relational positions	Reciprocity, trust, continuity, access, coordination, compatibility, and position	Treating relations as detachable private assets
Epistemic	Information, knowledge, warranted understanding, methods, data, and learning capacity	Access, reliability, interpretation, provenance, uptake, and communicability	Equating information volume or price with epistemic quality
Institutional	Rules, statuses, rights, routines, expectations, and governance arrangements	Recognition, legitimacy, enforcement, predictability, contestability, and durability	Treating institutional stability as intrinsically beneficial
Participatory	Capacity and recognized opportunity to take part in production, governance, valuation, or decision	Standing, voice, information, time, access, procedural rights, and effective uptake	Counting formal inclusion as effective participation
Option	Practically reachable alternatives and preserved possibilities for later action	Reversibility, access, switching capacity, slack, information, and institutional permission	Counting nominal choices that cannot realistically be exercised
Future	Significance realized or preserved across later periods, subjects, or generations	Durability, maintenance, uncertainty, inheritance, temporal access, and future conversion	Collapsing long-horizon significance into one present estimate without examining assumptions
Ecological	Ecosystem conditions, regenerative processes, resilience, habitat, and environmental support	Ecological integrity, scale, thresholds, regeneration, interdependence, and temporal continuity	Reducing ecological significance to a single market or monetary interface

nomically significant even when it is not exchanged, privately owned, or assigned a market price. A bridge, laboratory instrument, seed stock, water system, dwelling, or reserve of critical material can matter through the capacities and relations it supports as much as through its exchangeability.

Three distinctions are useful. The first separates *material presence* from *material usability*. A machine located in an organization can remain practically unusable because power, maintenance, software, trained operators, replacement parts, or regulatory approval are unavailable. A parcel of land can exist as a formally recognized asset while its productive or residential use depends on infrastructure, environmental conditions, access rights, or planning rules. Material value is therefore frequently conditional on complementary relations and institutions.

The second distinction separates *stock* from *service*. A durable object can be represented as a stock, while its economic significance is often realized through services

generated over time. A building provides shelter, workspace, accessibility, prestige, or locational advantage only through continuing occupancy and maintenance relations. Infrastructure similarly produces value through reliable operation rather than through physical existence alone. This temporal distinction matters when maintenance is deferred: the nominal material stock can appear stable while its capacity to generate services deteriorates.

The third distinction concerns material specificity. Physical resources are heterogeneous in quality, location, compatibility, divisibility, durability, and substitutability. Treating them as interchangeable quantities can be appropriate for some questions, yet become misleading where these properties determine conversion. Two medical devices with the same purchase price can differ sharply in maintenance requirements, training needs, clinical compatibility, or expected operating life. Material value analysis therefore benefits from identifying the properties that condition actual use rather than inferring value directly from physical quantity or acquisition cost.

Material value also interacts with other forms. A physical archive can embody epistemic value. A public square can have relational and participatory value. A machine can carry institutional value when certification, standards, and organizational routines make its output recognizable. These interactions do not eliminate the material dimension. They show why materiality can be one necessary analytical coordinate without becoming a complete theory of value.

14.2.2 Financial Value

Financial value concerns economic significance represented through money-denominated assets, liabilities, claims, cash flows, liquidity positions, credit relations, purchasing power, and financing capacity. Monetary representation is unusually powerful because it permits accounting, comparison, contracting, transfer, saving, borrowing, and planning across heterogeneous activities. For many allocative and organizational questions, financial value is therefore the most operationally important common interface.

Its practical force depends on institutions. Currency, banking arrangements, accounting rules, property and contract law, credit systems, payment infrastructures, and expectations about future acceptance all participate in the realization of financial value. The broader point is compatible with Polanyi's treatment of economic processes as institutionally organized rather than analytically separable from their social forms (Polanyi 1957). GRE uses this observation narrowly: money-denominated value can be highly portable across transactions while remaining dependent on the institutional conditions that make monetary claims credible and convertible.

Financial value should also be separated into functions that can diverge. A resource can have a high accounting valuation while being illiquid. A liquid asset can provide short-run payment capacity without supporting long-horizon productive capability. A credit line can have little immediate balance-sheet value to a project yet materially expand its ability to survive temporary shocks. A grant can carry financial value as spendable funds and institutional value as recognition by a credible funder. These distinctions make it possible to analyze financing conditions without treating

one monetary number as a sufficient description of the economic position.

The convertibility of financial value gives it a special role in heterogeneous value systems. Money can purchase equipment, labor time, travel, data access, insurance, or training. This convertibility is substantial but incomplete. Financial resources do not automatically produce knowledge, trust, legitimacy, capability, ecological regeneration, or participation. Their conversion depends on prices, institutions, timing, available suppliers, subject capacities, and relational conditions. A budget can exist while qualified personnel remain unavailable; compensation can be offered after a relation has been irreversibly damaged; funds can be allocated to ecological restoration where lost habitat cannot be recreated on the relevant timescale.

GRE therefore treats financial value as a powerful conversion medium and claim structure while keeping the conversion interface visible. This avoids two opposite errors: understating the organizing importance of money and treating monetary expression as an exhaustive measure of heterogeneous value.

14.2.3 Capability Value

Capability value concerns the significance of effective capacities to act, function, produce, learn, participate, maintain relations, or convert resources into states and activities that matter to the relevant subjects or evaluative framework. The distinction is closely aligned with the capability approach's separation of commodities and resources from what persons are actually able to do or be (Sen 1985; Sen 1992). Robeyns's reconstruction further emphasizes that personal, social, and environmental conversion factors mediate the movement from resources toward capabilities and functionings (Robeyns 2005). GRE adopts this conversion-sensitive insight while extending the analytical object beyond individual welfare questions when collective, organizational, relational, or generative capacities are at issue.

Capability value can be realized at several levels. An individual can acquire literacy, professional skill, physical mobility, or bargaining competence. A research group can acquire the collective capacity to run an experiment that no member could perform alone. A local government can develop administrative capacity to implement a programme. A community can build organizational capacity to maintain shared infrastructure. These cases differ in bearer and mechanism, yet share a common analytical concern: the economically significant object is an effective ability rather than merely the resource that might support it.

This form of value is particularly important for distinguishing provision from formation. Purchasing training creates an input; acquiring a robust skill requires learning, practice, retention, and often an environment in which the skill can be exercised. Providing software creates access to a tool; organizational capability depends on integration with workflows, knowledge, authority, support, and complementary systems. A capability-oriented analysis therefore asks whether the resource becomes usable capacity and under which conditions.

Capability value also has a temporal dimension. Some capacities depreciate without use, maintenance, or updating. Others become generative because exercising them produces further learning, reputation, networks, or access to additional resources. Capability can therefore function both as an outcome of earlier allocation

and as an input into later value generation. This recursive property links capability value to the book's broader interest in generative opportunity without implying that every capability is normatively desirable. Capabilities can support harmful or extractive action as well as beneficial activity; valuation still requires a specified standpoint.

14.2.4 Relational Value

Relational value concerns economic significance that is carried by, realized through, or materially conditioned by relations and relational positions. A relation can matter because it provides access, coordination, trust, recognition, information, continuity, reciprocity, mutual support, bargaining leverage, or compatibility. Its value can also arise from the relation itself when interaction, association, or shared activity is part of what participants value.

Existing work on relational goods provides one useful precedent. Uhlaner analyzes relational goods in connection with participation and sociability, Gui treats interpersonal encounters as productive processes capable of creating relational goods and relation-specific assets, and Donati develops a stronger relational-sociological account of emergent goods enjoyed through sharing (Uhlaner 1989; Gui 2000; Donati 2019). GRE uses a broader category of relational value. It can include relational goods in these senses, while also covering instrumental, infrastructural, institutional, and positional significance that depends on a relation without claiming that the relation itself is necessarily the valued good.

This breadth requires precision about the bearer of the value claim. Consider a long-standing supplier relation. One firm can value it because it reduces search and coordination costs; the supplier can value it as predictable demand; workers can value continuity; a regulator can value traceability; a local community can value the relation because it anchors employment. The relation is shared, while its value incidence is distributed and potentially asymmetric. A claim that the relation is valuable therefore needs a standpoint and a specification of the mechanism through which value is realized.

Relational value can also persist in configurations that are difficult to transfer. Trust, tacit coordination, shared routines, and mutual understanding can be relation-specific. Selling an organization's physical assets does not automatically transfer the same relational configuration to a new owner. Conversely, a relation can remain formally intact while its practical value erodes because expectations, personnel, standards, or background institutions change. Relational value is therefore often path-dependent and maintenance-dependent.

The category also includes negative or mixed incidence in the sense established by situated value attribution. A relation that gives one actor reliable access can make another dependent. Dense coordination can support collective capacity while raising entry barriers for outsiders. These cases reinforce the need to separate the existence of relational value from a claim that the relation is normatively good for every affected subject.

14.2.5 Epistemic Value

Epistemic value concerns economic significance associated with information, knowledge, warranted understanding, data, models, methods, explanatory capacity, provenance, and the ability to learn or reduce relevant uncertainty. It matters whenever action depends on what actors can know, infer, communicate, verify, or revise. The category therefore includes both epistemic contents and the infrastructures or capacities through which those contents become usable.

Economic theory has long recognized that information and knowledge differ from ordinary commodities. Arrow's analysis of inventive activity emphasizes uncertainty and difficulties of appropriation in the production of information, while Hayek emphasizes the coordination problem created by knowledge dispersed across persons and circumstances (Arrow 1962; Hayek 1945). GRE draws a limited implication from these traditions: the value of knowledge cannot be inferred solely from its physical carrier or exchange price because access, interpretation, credibility, timing, and relation to action affect whether it becomes economically consequential.

Several layers should therefore be distinguished. *Informational availability* concerns whether data or statements are accessible. *Epistemic usability* concerns whether a subject can interpret and apply them. *Epistemic warrant* concerns the quality of the relation between a claim and the evidence or method supporting it. *Epistemic uptake* concerns whether organizations or institutions actually incorporate relevant knowledge into decisions. A dataset can be open yet unusable; a correct warning can be ignored; an expensive report can rest on weak evidence; tacit knowledge can be highly valuable while being difficult to codify or transfer.

Epistemic value can also be generative. A method can produce new findings; a dataset can support multiple later inquiries; a well-documented failure can prevent repeated error; a trusted provenance system can make future verification less costly. The generative effect depends on accessibility, preservation, standards, interpretive capacity, and institutional uptake. These conditions help explain why knowledge infrastructure can have economic significance beyond the immediate output of any one research project.

Epistemic value should not be equated with whatever information commands a price or produces strategic advantage. False information can have market value to an actor who sells it while having negative epistemic quality. Secret information can have private strategic value while reducing collective epistemic access. Keeping these distinctions visible allows GRE to analyze the economic organization of knowledge without collapsing truth, usefulness, price, and power into one dimension.

14.2.6 Institutional Value

Institutional value concerns economic significance carried by rules, rights, statuses, routines, standards, governance arrangements, enforcement mechanisms, recognized categories, and stabilized expectations. Institutions can lower uncertainty, coordinate expectations, authorize action, define claims, create procedural access, distribute responsibilities, and make forms of cooperation durable. They can also entrench exclusion, impose rigidity, or stabilize relations that benefit some positions

at the expense of others. Institutional value is therefore standpoint- and function-dependent rather than a synonym for institutional persistence.

Polanyi's conception of the economy as an instituted process provides a classical basis for treating economic activity as organized through institutional patterns rather than through exchange alone (Polanyi 1957). Ostrom's work on common-pool resources provides a different but complementary precedent: durable collective governance can emerge through varied institutional arrangements, while similar resource problems can also produce institutional failure (Ostrom 1990). GRE does not infer one preferred institutional form from these traditions. It uses them to keep the architecture of rights, rules, monitoring, decision, and recognized standing visible as an economic source of value and constraint.

Institutional value can be realized through predictability. A clear property right, procurement rule, certification system, or dispute-resolution procedure can reduce uncertainty and coordination costs. It can also be realized through authorization. Legal status can permit an organization to contract, hold assets, receive funds, or participate in a regulated activity. A professional credential can make capability institutionally legible. A standard can create interoperability across organizations. In each case, part of the value arises because a wider institutional environment recognizes and responds to the relevant status or rule.

Yet institutionalization also creates path dependence. Once budgets, information systems, contracts, roles, and expectations are organized around a category, changing it can become costly. Institutional value can therefore coexist with institutional lock-in. A stable rule can preserve coordination while becoming poorly adapted to new conditions. The relevant question is not whether institutionalization is valuable in the abstract, but which functions it performs, for whom, under which conditions, and with what possibilities for revision or contestation.

Institutional value often acts as a conversion condition for other forms. Financial resources can be unusable without authorization. Capability can remain unrecognized without credentials. Participation can be nominal without procedural rights. Ecological protections can depend on enforceable institutions. This mediating role makes institutional analysis central to heterogeneous value conversion later in the chapter.

14.2.7 Participatory Value

Participatory value concerns the economic significance of being able to take part in production, governance, collective learning, valuation, agenda formation, or decisions that shape relevant conditions. Participation can matter instrumentally because it improves information, coordination, legitimacy, or implementation. It can also matter as part of the valued condition itself when subjects or collectives value agency, voice, self-determination, recognition, or shared authorship.

The capability tradition gives participation a prominent place within broader accounts of freedom and public action. Drèze and Sen, for example, connect development with agency and complementary social and political institutions rather than with income growth alone (Drèze and Sen 2002). Generative-justice work also emphasizes participation by value generators in the benefits and conditions of production

(Eglash 2016). GRE draws on these precedents while keeping participatory value analytically open: the relevant form of participation and its evaluative standing depend on the economic process under study.

Formal inclusion provides only one layer. Effective participation can depend on information, time, language, mobility, technical knowledge, procedural standing, psychological safety, organizational capacity, and whether contributions receive meaningful uptake. A meeting open to all can remain effectively inaccessible to persons who cannot attend, understand the materials, or influence the decision. A worker can be invited to consult while core choices remain predetermined. A community can supply local knowledge without gaining any role in defining objectives or evaluating outcomes. Participatory value therefore requires attention to the conditions that convert nominal access into effective involvement.

Participation can itself generate other forms of value. Repeated participation can build capability, trust, shared knowledge, institutional memory, and collective capacity. It can also consume time, impose coordination burdens, or expose participants to risk. More participation is consequently not a universal proxy for better outcomes. The analytical question concerns which participatory opportunities are material to the process, how their costs and benefits are distributed, and whether affected subjects have meaningful influence over matters relevant to them.

This form also clarifies why participation cannot be reduced to relational value. Participation always occurs through relations, yet its distinctive analytical object is the subject's recognized and effective position in shaping an activity or its conditions. A relation can be valuable without conferring voice; participation can be valuable even in temporary or weakly personal institutional settings.

14.2.8 Option Value

Option value concerns the economic significance of preserving or creating practically reachable alternatives for later action. In GRE, the term is used in a broad analytical sense rather than as a direct import of financial-option pricing. The valued object is the availability of a future course of action under conditions where uncertainty, irreversibility, learning, or changing preferences make premature closure consequential.

A practical option has several components. The alternative must be recognizable, institutionally or technically permissible, materially accessible, and within the subject's effective capacity to exercise. A formal right to change provider has little option value if switching costs are prohibitive. A research programme has more option value when data, methods, and infrastructure remain reusable across several future questions. A reversible pilot can preserve more later alternatives than a commitment that requires large sunk investments and locks an organization into one technical architecture.

This formulation connects option value to the distinction between resources and effective opportunity developed in capability analysis (Sen 1999). It also extends the Chapter 13 analysis of option-space effects. Nominal alternatives do not establish meaningful option value when access, standing, information, or conversion capacity make them practically unreachable. Conversely, a modest amount of slack, redundancy, interoperability, or reversible capacity can carry substantial option value

when uncertainty is high.

Option value is relational and historical. An option available to one subject can depend on another actor's cooperation, on institutional permission, on standards, or on the persistence of complementary infrastructure. Its value can rise or fall as circumstances change. Keeping an emergency reserve can be low-value under stable conditions and crucial under disruption. Maintaining several scientific approaches can appear inefficient in a settled period and become valuable when a dominant model encounters anomalous evidence.

Preserving options also has costs. Redundancy consumes resources; delayed commitment can forgo scale economies; interoperability can constrain local optimization; maintaining exit routes can reduce relation-specific investment. GRE therefore treats option value as one value form among others. It becomes analytically important when uncertainty, reversibility, adaptation, or future learning materially affect the question.

14.2.9 Future Value

Future value concerns economic significance that is expected, preserved, generated, or realized across later periods, including cases in which affected subjects or institutions differ from those making present decisions. The category is broader than a discounted financial future value. It includes later capability, ecological conditions, institutional durability, knowledge, inherited infrastructure, future options, and burdens or benefits transmitted across generations.

A basic distinction separates *anticipated value* from *later realized value*. Present actors can form expectations about future significance, but those expectations remain conditional on knowledge, uncertainty, institutional continuity, technological change, and later conversion conditions. A long-lived infrastructure project can be expected to generate services for decades while actual value depends on maintenance, demographic change, climate conditions, complementary systems, and future patterns of use. Future value analysis therefore needs to keep the epistemic status of present forecasts separate from the later value that may eventually be realized.

A second distinction concerns the identity of future beneficiaries and bearers of cost. Intergenerational resource economics provides a narrow but important precedent for treating present resource use and investment as consequential for later consumption possibilities (Solow 1974; Hartwick 1977). GRE generalizes the analytical concern without importing the assumptions of those specific models. Present choices can transmit material stocks, ecological conditions, institutions, debt, knowledge, capabilities, infrastructures, and option structures to later subjects. The resulting future value can therefore involve heterogeneous forms rather than one aggregate stock.

Future value also raises a representation problem. Discounting can be appropriate for some financial comparisons, yet a single discount rate does not by itself resolve questions about irreversible ecological loss, institutional degradation, long-lived capability, uncertain technological change, or the standing of future subjects. GRE does not reject discounting as a technique. It treats the choice of temporal representation, horizon, and assumptions as part of the value analysis when they materially affect

the conclusion.

The future-value category is also distinct from option value. Option value concerns the significance of preserving reachable alternatives. Future value concerns significance realized or preserved later, whether or not it takes the form of a choice set. A durable bridge can have future value through continued service even if it does not expand options. A preserved wetland can have future ecological value and option value at the same time. The distinction permits later analysis to track temporal incidence without reducing every long-horizon value to flexibility.

14.2.10 Ecological Value

Ecological value concerns economic significance carried by ecosystems, species assemblages, regenerative processes, environmental quality, resilience, habitat, biophysical cycles, and other ecological conditions that support or constrain economic and social life. The category is included because economic processes are materially embedded in ecological systems and because ecological change can alter production, health, settlement, risk, infrastructure, and future possibility over long horizons. Ecological economics provides an established interdisciplinary precedent for analyzing relations between economic and ecological systems in this broad sense (Costanza 1989).

Ecological value can enter analysis through several interfaces. Some ecological conditions provide direct material inputs such as water, biomass, or soil fertility. Others regulate floods, temperatures, disease exposure, or nutrient cycles. Habitats can support species and regenerative processes whose economic effects are distributed across time and space. Landscapes can also carry cultural, relational, aesthetic, or identity significance. These interfaces can overlap without being reducible to one another.

The value of an ecological condition can therefore exceed its current extractive use. A forest can supply timber while also affecting water regulation, habitat, carbon storage, recreation, local livelihoods, and future ecological resilience. A coastal wetland can occupy land with development value while reducing storm risk and supporting ecological continuity. Monetary valuation can help compare some of these effects, but the translation depends on methods, assumptions, affected populations, institutional purposes, and what remains outside the metric. Fourcade's analysis of economic valuation of nature is useful precisely because it treats monetary valuation as a socially organized translation with feedback effects rather than a neutral revelation of a pre-existing number (Fourcade 2011).

Ecological value is also multiscale. A locally beneficial activity can impose downstream or long-horizon ecological costs; a conservation measure can create concentrated local burdens while producing wider benefits. Governance of common-pool resources illustrates that ecological value is often inseparable from institutional arrangements concerning access, monitoring, use, exclusion, and collective action (Ostrom 1990). The relevant value incidence can therefore cross property boundaries, jurisdictions, organizations, and generations.

GRE maintains ontological and disciplinary restraint here. Ecological systems should not be absorbed into economics merely because they have economic conse-

quences. Some evaluative frameworks attribute intrinsic or non-instrumental value to ecological beings and processes; others emphasize human welfare, resilience, rights, cultural significance, or intergenerational obligation. The present section does not decide among these frameworks. It identifies ecological value as an analytically necessary form when ecological conditions materially affect the phenomenon or when the evaluative standpoint itself assigns significance to them.

The ten forms developed in this section provide a reusable vocabulary for tracing heterogeneous value without presuming that one form is primary. Proposition 14.4 states the corresponding scope principle.

Proposition 14.4 (Non-exclusivity of value forms)**.** *Within a GRE inquiry, classifying an economically significant object, relation, institution, process, or trajectory under one value form does not establish that its value incidence is exhausted by that form. Where several forms are materially relevant, analysis should preserve their distinct realization conditions and make any conversion, aggregation, or substitution among them explicit.*

Proposition 14.4 does not require every inquiry to use the full taxonomy. A narrow financial question can remain financial; a capability inquiry can focus on capabilities; an ecological study can use domain-specific ecological categories. The proposition becomes consequential when an argument moves across value forms while leaving the conversion unexamined. The next stage of the chapter can therefore ask how value becomes manifest through relations, subject positions, institutions, and historical conditions while retaining the plurality established here.

14.3 Value as Relational Emergence

Sections 14.1 and 14.2 established a plural and ontologically restrained value architecture. The role of the present section is to specify how value can become economically consequential through relations without turning relational emergence into a final metaphysical thesis. Its objective is to identify the conditions under which value is realized, differentiated, manifested, recognized, symbolized, and made operative for differently situated subjects and collectives. The discussion proceeds through relational conditions, subject position, historical and institutional conditions, manifestation, symbolization, and ontological restraint. The method is conceptual and register-sensitive: it distinguishes the relational organization through which significance becomes consequential from the manifestations and symbols through which that significance becomes accessible, while preserving the book's suspension concerning ultimate ontology.

The phrase *relational emergence of value* therefore carries a limited meaning. It does not assert that relation is the ultimate substance of value, that value exists only when socially recognized, or that every economically significant property can be dissolved into social interaction. It identifies a recurrent analytical fact: what an object, capability, institution, ecological condition, or possible trajectory can do and what significance it carries frequently depend on the relations in which it is embedded, the position from which it is encountered, the historical conditions that make particular conversions possible, and the institutions and symbolic regimes through which its significance becomes actionable. Material properties can remain indispensable

Table 14.3: Dimensions of value as relational emergence

Dimension	Primary analytical question	Illustrative mechanisms	Characteristic reduction risk
Relational conditions	Through which relations can significance be realized or converted?	Complementarity, dependence, coordination, access, maintenance, interoperability, reciprocity	Treating value as a detachable property of an isolated bearer
Subject position	For which situated subject or collective does the significance arise?	Rights, capabilities, obligations, exposure, knowledge, bargaining position, identity, role	Reducing situated significance to private preference alone
Historical conditions	Which prior processes make the present significance possible or salient?	Changing scarcity, technology, institutions, conventions, infrastructures, trajectories	Treating present value categories as timeless
Institutional conditions	Which rules and recognized statuses make value actionable or legible?	Property, law, accounting, standards, credentials, authorization, governance	Treating institutional recognition as exhaustive of value
Manifestation	Through what observable or experience-accessible forms does value become accessible?	Use, performance, price, participation, ecological response, testimony, records	Identifying a manifestation with the full relational configuration
Symbolization	Which symbolic forms encode, communicate, compare, or operationalize value?	Prices, rankings, accounts, labels, indicators, contracts, classifications	Treating symbolic representation as neutral or complete
Ontological restraint	What can be claimed without converting analysis into metaphysical settlement?	Register distinction, purpose-relative representation, multiple realization, revisability	Inferring ultimate ontology from analytical usefulness

within this account. Relational emergence concerns the organization of significance, not the denial of materiality.

Definition 14.5 fixes this limited use.

Definition 14.5 (Relational emergence of value)**.** Within GRE, the *relational emergence of value* is the process through which economically relevant significance becomes realized, differentiated, stabilized, transformed, or made actionable through a historically situated configuration of relations among bearers, subjects, collectives, institutions, environments, evaluative frameworks, and conditions of access or conversion. The term identifies a relational mode of realization and does not by itself establish the ultimate ontology of value.

Definition 14.5 is compatible with the situated value attribution introduced in Definition 14.1. A value attribution can be positive, negative, or mixed relative to particular subjects and horizons, while relational emergence asks how the conditions making that significance economically operative came to be organized. The two concepts should remain distinct. Attribution identifies significance from an evaluative position; emergence identifies the relational conditions through which that significance becomes possible, effective, or visible.

Table 14.3 summarizes the seven analytical dimensions developed below. The dimensions overlap and can operate recursively. Institutions can alter subject positions; symbolic classifications can change institutional treatment; historical change can reorganize relational conditions; manifestations can feed back into later valuation. The table therefore provides an analytical map rather than a linear sequence.

14.3.1 Relational Conditions

Relational conditions concern the connections, complementarities, dependencies, access relations, maintenance arrangements, and coordination structures through which a potential source of value becomes economically consequential. Their role in the present section is to explain why significance frequently cannot be inferred from an object considered in isolation. The analytical object is neither relation in the abstract nor a general claim that everything is relational. It is the specific configuration whose presence or absence materially changes realization, use, conversion, distribution, or continuation of a value form.

Many familiar economic cases have this structure. A machine has limited productive significance without energy, compatible inputs, maintenance, trained operators, organizational routines, and demand for what it produces. A credential matters differently across institutions that recognize or disregard it. Money has purchasing power through a wider monetary, legal, accounting, and exchange architecture. Scientific knowledge can remain economically inert when the relevant organization lacks absorptive capacity, implementation authority, or complementary infrastructure. A wetland can carry ecological value through relations among hydrology, habitat, settlement patterns, land-use institutions, and downstream exposure. In each case, the bearer matters, yet the realized significance depends on a configuration extending beyond the bearer.

This point has precedents in economic sociology and institutional economics. Polanyi's formulation of the economy as an instituted process emphasizes that economic activity is organized through historically specific institutional patterns rather than existing as an autonomous exchange mechanism (Polanyi 1957). Zelizer's account of relational work provides a different perspective in which economic transactions are differentiated through social relations and negotiated meanings rather than governed by a single undifferentiated market logic (Zelizer 2012). GRE does not identify itself with either framework. The relevant implication is narrower: economic significance can depend on the organization of relations through which an object or process becomes usable, transferable, legitimate, trusted, or convertible.

Relational conditions can be constitutive, enabling, amplifying, constraining, or destructive. A complementary relation can make a capability usable. A distribution network can amplify the reach of a product. A restrictive contractual relation can convert nominal ownership into weak practical control. A trust relation can reduce verification costs while a dependency relation can narrow exit. These mechanisms can coexist. A platform can create market access for a small producer while simultaneously making future access dependent on ranking systems, technical standards, or unilateral rule changes. The relevant value profile therefore depends on the configuration rather than on a generic judgment that the relation is beneficial or harmful.

Relational realization also differs from relational ownership. A subject can realize value through a relation without owning the relation or the entities participating in it. A patient can benefit from a functioning referral network; a researcher can gain epistemic value from an open scholarly community; a resident can benefit from reliable public transport; a firm can gain from standards maintained by an industry consortium. Conversely, ownership of an asset does not guarantee realization when critical

relations remain unavailable. This distinction reinforces the argument of Chapter 14: possession can matter while remaining analytically incomplete for some questions.

A further distinction concerns relation-specificity. Some value survives substantial changes in relational context, while other value is highly specific to a particular configuration. A standardized financial asset may retain much of its significance across owners and locations. Tacit coordination among a long-standing team can be difficult to transplant. Ecological value can depend on spatially specific relations that cannot be recreated by moving individual components. GRE should therefore avoid assuming either complete portability or complete embeddedness. The degree of relational specificity is an empirical and interpretive question tied to the mechanism under study.

14.3.2 Subject Position

Subject position concerns the situated relation from which economic significance is experienced, exercised, recognized, borne, or evaluated. Its role is to prevent a move from the statement that something is valuable to the stronger and often unsupported claim that it carries the same value for every affected subject. Subject position includes rights, capabilities, obligations, exposure, knowledge, institutional standing, relational dependence, role, identity, and practical access to conversion conditions. These dimensions can make the same object or process differently significant across persons and collectives.

Capability analysis provides a clear precedent for separating resources from what differently situated persons can effectively do with them. Sen's capability approach emphasizes that the same commodity bundle or resource level can support different substantive freedoms because personal, social, and environmental conversion conditions differ (Sen 1985; Sen 1992; Sen 1999). GRE retains this distinction while broadening the relational field. A subject's position can depend not only on individual conversion characteristics but also on institutional recognition, network position, access to collective infrastructure, dependency relations, linguistic interfaces, technical standards, and the future consequences of participation.

Subject position should also be distinguished from subjective preference. Preferences can be economically relevant, yet the subject's relational location can affect value even when explicit preference is absent, unstable, constrained, or poorly informed. A worker can occupy a position exposed to occupational risk before forming a settled preference about that risk. A future generation can bear ecological consequences without present preferences. A small supplier can depend on a dominant buyer even when the supplier presently prefers to maintain the relationship. A patient can possess a legal entitlement whose practical value depends on referral rules and geographic access. Situated significance therefore includes the conditions under which preference formation, choice, and agency themselves become possible.

Positions can also be multiple. The same person can be a worker, consumer, caregiver, resident, citizen, debtor, investor, and member of an ecological community, with different value incidences across these roles. An organizational decision that improves returns to the person as shareholder can increase burdens in the person's role as employee or resident. A digital service can generate convenience as a user

while increasing exposure as a data subject. GRE does not require these positions to be aggregated into a single utility representation unless the inquiry provides a justified conversion rule. Preserving positional plurality can be analytically necessary when one intervention redistributes significance across the same subject's different relations.

Collective subject positions require similar care. A community, profession, organization, state, or future public can sometimes be a meaningful evaluative or practical unit, yet collective attribution should not erase internal heterogeneity. A policy may generate institutional value for an organization while distributing costs unevenly among members. A regional infrastructure can strengthen collective productive capacity while displacing particular households. A scientific norm can improve collective epistemic reliability while imposing unequal compliance burdens across institutions with different resources. Collective value claims should therefore identify whose position is being represented and where internal differences materially affect the analysis.

Subject positions can change through the very processes being valued. Education can transform a learner's capabilities and institutional standing. Employment can create income while also changing skills, networks, obligations, and future bargaining position. A participatory institution can alter who possesses recognized voice. A technological platform can generate new producer roles while redefining dependence and visibility. Value is consequently not always evaluated from a fixed subject position; the position itself can be historically generated, stabilized, or transformed.

14.3.3 Historical Conditions

Historical conditions concern the prior trajectories through which present value relations have become possible, salient, scarce, legitimate, or intelligible. Their role is to keep value analysis from treating current categories as timeless properties. The objective is not to reconstruct the full history of every valuable object. It is to identify those historical processes that materially condition present realization, interpretation, conversion, or evaluation.

The economic significance of objects can change when scarcity, productive forces, technology, infrastructure, law, cultural practice, or institutional organization changes. A mineral can shift from marginal use to strategic importance when a new technology depends on it. A dataset can gain value after computational methods make previously inaccessible analyses feasible. Urban land can acquire new significance after transport infrastructure changes accessibility. A credential can gain or lose value as labor-market institutions and professional jurisdictions change. A species or ecosystem can become newly salient when scientific understanding reveals a previously weakly recognized ecological function. These changes need not alter the physical bearer in order to transform its economic significance.

The social life and historical biography of objects provide useful precedents for this process-sensitive view. Appadurai's discussion of commodities emphasizes that commodity status and value can vary across contexts and trajectories, while Kopytoff's account of the cultural biography of things examines how objects can move through different regimes of commoditization and classification (Appadurai 1986; Kopytoff

1986). GRE uses these works as reminders that economic status can be historically organized. It does not infer that material properties or productive conditions are secondary. Historical value analysis asks how material, relational, institutional, and symbolic conditions interact in making a particular form of significance operative at a particular time.

Historical conditioning also matters for comparison. A nominal monetary amount, institutional title, land category, professional qualification, or technological capability can have different practical significance across periods because the relations supporting conversion have changed. Historical comparison therefore requires more than adjusting units. It may require reconstructing the surrounding institutions, alternative opportunities, legal rights, background infrastructures, technologies, and value conventions through which the observed quantity acquired meaning.

Path dependence can further make present value contingent on earlier sequences. Complementary investments, standards, reputations, legal precedents, accumulated trust, sunk infrastructures, and learned practices can make a current object valuable partly because a history has organized the environment around it. Another object with similar intrinsic properties can then realize less value because the supporting trajectory is absent. The relevant conclusion is not that history determines value uniquely. Historical contingencies can be disrupted by innovation, institutional change, crisis, social movements, or changing evaluative frameworks. The point is that present value can inherit conditions produced by prior events.

Historical conditioning also applies to what is considered a legitimate value category. The boundary between household activity and market production, the status of environmental services, the meaning of intellectual property, the recognition of care work, and the valuation of data have changed across institutions and periods. GRE therefore treats value categories as historically revisable. A category can become more adequate when new distinctions are recognized, and it can become less adequate when it suppresses processes that have become economically material.

14.3.4 Institutional Conditions

Institutional conditions concern the rules, statuses, procedures, recognized categories, standards, rights, enforcement mechanisms, and organizational routines through which value becomes actionable, durable, transferable, or contestable. Their role differs from the broader historical conditions discussed above. Historical analysis asks how the present configuration came to be; institutional analysis asks how currently operative arrangements organize the realization and recognition of significance.

Institutional conditions can create practical convertibility. A legal title can make a claim transferable. A professional credential can convert prior learning into recognized access to employment. An accounting rule can make a resource legible to budgeting and audit systems. A technical standard can make independently produced components interoperable. A procurement rule can open or close a market. A citizenship or residency status can alter access to social rights and public services. These institutions do more than record value. They establish interfaces through which material, financial, capability, relational, and participatory significance can be converted

into recognized claims and actions.

The importance of institutional mediation does not imply that recognized value exhausts economic significance. An unpaid caregiving activity can remain economically consequential despite weak representation in market accounts. Ecological conditions can matter before an institution prices them. Tacit knowledge can carry productive value without formal credentialing. Informal trust can support exchange where contracts are incomplete. Institutional recognition can therefore lag, compress, or selectively represent a wider value configuration.

Institutionalization can also produce value by stabilizing expectations. Property systems, contract law, standards, organizational roles, dispute-resolution procedures, and accounting conventions can reduce uncertainty and make coordination possible across strangers or long horizons. Polanyi's instituted-process perspective is relevant here because it places economic organization inside institutional structures rather than treating institutions as external additions to an otherwise complete market process (Polanyi 1957). GRE extends the point by asking how different institutional arrangements shape the realization and conversion of heterogeneous value forms.

Institutional categories also distribute visibility and standing. Valuation and evaluation studies emphasize that classification, commensuration, and institutionalized criteria can organize which differences become salient and comparable (Lamont 2012; Espeland and Stevens 1998). A funding rule can make one kind of output legible while ignoring another. A ranking can privilege standardized indicators over locally valued practices. An eligibility category can turn a continuous social condition into a threshold for receiving support. These mechanisms can be administratively necessary while still leaving relational and historical remainders outside the institutional representation.

Institutional conditions are themselves objects of valuation and contestation. A rule can be valued for predictability by one actor and experienced as exclusionary by another. A credential can protect quality while creating entry barriers. A standard can support interoperability while concentrating control over its revision. The section therefore does not treat institutions as neutral containers for pre-existing value. Institutional arrangements participate in the emergence, distribution, manifestation, and transformation of value while remaining open to evaluation from several subject positions.

14.3.5 Manifestation of Value

Manifestation concerns the forms through which value becomes accessible to experience, observation, measurement, practical use, or inquiry. Its role in this section is to connect the value architecture of Chapter 14 to the book's three-register distinction among ontological, relational, and manifestational reality. A relationally consequential value configuration can become manifest through use, performance, exchange, price, participation, institutional treatment, ecological response, testimony, record, or another context-sensitive form. The manifestation provides epistemic and practical access while remaining analytically distinct from the relational configuration through which the significance is generated.

Definition 14.6 adapts the book's general manifestation architecture to value anal-

ysis.

Definition 14.6 (Value manifestation)**.** A *value manifestation* is a context-sensitive, relatively stable form through which economically relevant significance becomes accessible to a subject, practice, institution, measurement system, or inquiry. A manifestation can provide evidence of value, enable its use, or participate in its reproduction, while remaining non-identical to the full relational configuration from which the significance arises.

The definition allows manifestations to be heterogeneous. A market price can manifest financial valuation. Successful task performance can manifest capability. Repeated collaboration can manifest relational value. Citation use, replication, or successful application can manifest some dimensions of epistemic value. A stable legal status can manifest institutional recognition. Attendance and effective influence can manifest participatory value. Species recovery or improved water quality can manifest some ecological effects. These forms differ in what they make accessible and in the inferential burden required to move from manifestation to a broader claim about value.

Manifestation is generally non-invertible. A high price can arise from scarcity, market power, speculation, expected future demand, quality, or several interacting mechanisms. Similar observed productivity can rest on different capability structures. Similar participation rates can conceal very different distributions of influence. Similar accounting values can represent assets with different ecological, relational, or option-space consequences. Conversely, one relational configuration can produce different manifestations across institutions, populations, scales, or historical periods. Value analysis should therefore avoid treating a single manifestation as a unique revelation of the underlying value relation.

This distinction is particularly important when value remains weakly manifested. Future value can be difficult to observe before relevant conditions unfold. Ecological value can remain weakly represented until a disturbance reveals a system's regulatory function. Tacit knowledge can become visible only after a knowledgeable worker leaves. Institutional trust can remain latent until crisis tests it. A capability can exist without being exercised in every period. Absence of a salient manifestation should consequently be distinguished from evidence that the relevant value configuration is absent.

Manifestations can also become causally operative. A reported price affects expectations and contracts. A performance indicator changes resource allocation. A public demonstration of capability alters bargaining position. A visible ecological failure changes regulation and investment. Once the manifestation enters subsequent relations, it participates in the generative history rather than remaining a passive surface. This recursive possibility prepares the move to symbolization, where manifestations become encoded in forms that can travel, compare, classify, and coordinate across wider institutional settings.

14.3.6 Symbolization of Value

Symbolization concerns the production and use of prices, numbers, categories, rankings, accounts, labels, narratives, contracts, certificates, indicators, and other sym-

bolic forms through which value is encoded, communicated, compared, stored, or made administratively operative. Its role differs from manifestation more broadly. A value can manifest in use, bodily experience, ecological change, institutional practice, or relation-specific performance without first being explicitly symbolized. Symbolization selects and organizes some manifestations within a symbolic regime.

Money and price provide familiar symbolic forms, but value symbolization extends much further. Accounting systems classify assets, liabilities, costs, and income. Credit ratings symbolically compress assessments of repayment risk. Educational credentials encode institutional recognition of learning. ESG indicators represent selected environmental and social characteristics. Rankings translate heterogeneous organizational activities into ordered comparisons. Legal categories symbolize status and entitlement. Platform scores summarize activity into signals that can alter visibility or access. The practical force of these symbols depends on the institutions, conventions, technologies, and audiences that recognize them.

Commensuration is one important form of symbolization because it transforms qualitatively different objects into a common metric. Espeland and Stevens treat commensuration as a social process that can reshape attention and relations rather than merely recording pre-existing comparability (Espeland and Stevens 1998). Lamont similarly emphasizes that valuation and evaluation operate through culturally and institutionally organized criteria (Lamont 2012). These approaches support a restrained GRE claim: symbolic value forms can be analytically and practically powerful while remaining historically situated constructions whose scope and consequences require examination.

Symbolization can increase portability. A monetary amount, standardized score, legal title, or credential can travel across contexts more readily than the full relational history from which it emerged. This portability can support coordination, comparison, exchange, audit, governance, and large-scale administration. It can also compress differences. Two organizations with the same rating can possess different capacities; two properties with the same assessed price can carry different ecological or social significance; two persons with the same credential can have different practical capabilities. Symbolic efficiency therefore trades on selective abstraction.

Symbolic forms can also feed back into the value they represent. Rankings can alter organizational behavior, strategic priorities, and resource allocation; Espeland and Sauder document such reactivity in institutional rankings (Espeland and Sauder 2007). A price signal can change production and demand. A legal classification can create access to benefits or restrictions. A certification can increase marketability. A repeated public label can alter reputation and future opportunity. Symbolization can therefore participate in value generation, stabilization, concentration, or erosion. The effect depends on who controls the symbolic regime, which categories are recognized, and how strongly later institutions respond to the symbol.

Bourdieu's analysis of symbolic power is relevant to this asymmetry because naming and classification can acquire force when backed by recognized authority and social structure (Bourdieu 1991). GRE does not import Bourdieu's full theory of fields or symbolic capital into its value ontology. The narrower point is that symbolization is not equally available to every actor. Some institutions possess greater capacity to define categories, certify quality, publish authoritative metrics, set accounting rules,

or make classifications consequential. Control over value symbols can therefore become one component of control over value conversion and recognition.

The practical usefulness of symbolization should consequently be separated from completeness. A well-designed metric can be entirely adequate for a stated purpose without exhausting the value domain. A standardized price can coordinate exchange without representing ecological or participatory value. A capability indicator can support comparison without capturing every locally meaningful function. A legal status can secure rights while omitting informal relations that shape practical access. The relevant requirement is purpose-relative adequacy and visibility about what the symbolic representation retains, compresses, or excludes.

14.3.7 Value without Ontological Reduction

The relational-emergence account developed in this section is intentionally stronger than a purely subjective theory of valuation and weaker than a claim that value is fundamentally relational in ultimate ontology. It is stronger than a preference-only account because material properties, ecological processes, institutions, histories, capabilities, and relational positions can condition economic significance even when they are not reducible to an individual's present preference. It is ontologically restrained because the analytical success of a relational account does not establish that relation is the final metaphysical substance from which every form of value derives.

This restraint is especially important across the book's three registers of reality. At the relational register, a value configuration can become sufficiently stable and causally efficacious to organize action. At the manifestational register, selected dimensions of that configuration become accessible through use, experience, observation, records, or other manifestations. Symbolic regimes can further encode some manifestations into prices, indicators, categories, narratives, or legal forms. The ontological register remains more open. GRE can analyze these processes rigorously while suspending stronger claims about whether value is ultimately objective, subjective, relational, emergent in a metaphysical sense, or constituted through some other ontology.

Ontological restraint also prevents a reverse reduction from symbolism to unreality. A symbolically mediated value can be relationally real because institutions and practices make the symbol causally efficacious. Money, legal status, credit ratings, credentials, and organizational classifications can shape action precisely because symbolic and institutional relations sustain them. Their dependence on symbolic regimes does not make their effects imaginary. At the same time, causal efficacy does not establish that the symbol perfectly represents the value it helps organize.

The same restraint applies to material value. Relational emergence does not imply that physical characteristics are arbitrary constructions. Water quality, energy density, structural strength, biological compatibility, and ecological thresholds can constrain economic possibilities independently of how actors describe them. Their economic significance nevertheless becomes situated through access, technology, institutions, needs, subject positions, and alternative possibilities. GRE therefore retains material constraint and relational realization within the same analytical frame.

Relational emergence should likewise be distinguished from social consensus. A

value configuration can be contested. Different subjects can attribute opposing significance to the same object or institution, and one subject's value realization can generate another subject's burden. Some value can remain weakly recognized by dominant institutions while being strongly consequential for marginalized groups, future subjects, or ecological systems. Emergence therefore does not require unanimous valuation. It concerns the organization of significance within a relational field whose positions can conflict.

The ontological discipline of the section can be stated as Proposition 14.7.

Proposition 14.7 (Relational emergence with ontological restraint)**.** *When an economically relevant significance depends materially on relations, subject positions, historical conditions, institutional arrangements, manifestations, or symbolic regimes, GRE may analyze that significance as relationally emergent within the specified domain. Such an analysis warrants claims about the organization, realization, manifestation, or consequences of value at that level; it does not by itself warrant a stronger conclusion about the ultimate ontological nature of value.*

Proposition 14.7 provides a scope rule for the rest of the chapter. It permits later sections to analyze value generation, transmission, conversion, recirculation, accumulation, dissipation, harm, measurement, and historical transformation without requiring one metaphysical theory of value to be settled first. It also preserves a route for correction: where material properties, non-relational mechanisms, domain-specific theories, or alternative ontological commitments explain the phenomenon more adequately, GRE should retain them rather than forcing translation into relational language.

The analytical result is therefore modest but consequential. Value can be treated as historically and institutionally situated, relationally realized, manifestationally accessible, and symbolically organized while remaining ontologically open. This architecture prepares the next section's more specific question: through which transformations are value-bearing resources, capacities, relations, knowledge, institutions, participatory positions, options, and multiscale configurations generated over time?

14.4 Value Generation

Sections 14.1–14.3 established a plural and relationally situated account of value: economically significant objects, relations, institutions, processes, and trajectories can carry several value forms; their significance can depend on subject position, historical conditions, institutional arrangements, manifestation, and symbolization; and these analytical claims remain compatible with ontological suspension. The role of the present section is to specify a further distinction required by the rest of the chapter: the distinction between conditions that already bear value and processes through which value-bearing conditions are produced, expanded, reorganized, or made practically realizable. Its objective is to identify recurrent pathways of value generation without reducing generation to commodity production, monetary appreciation, or any single value form. The discussion proceeds through resource transformation, capacity formation, relation formation, knowledge generation, institutional formation, participation, option generation, and multiscale generation. The method is concep-

tual and mechanism-oriented. It asks what changes, through which mediating conditions, for whom or for what evaluative standpoint, and with what later consequences.

Value generation, as used here, is broader than production in the conventional sense and narrower than the claim that any change produces value. A manufacturing process can generate material and financial value; education can generate capability and epistemic value; a durable cooperative arrangement can generate relational and institutional value; an inclusive governance procedure can generate participatory value; a reversible technical architecture can generate option value; ecological restoration can generate or regenerate ecological value. In each case, the evaluative vocabulary becomes appropriate only after the relevant significance and standpoint have been specified. A process can be generative in the descriptive sense while producing value for some positions, burdens for others, and ambiguous or contested consequences at wider scales.

Three distinctions organize the section. First, *generation* differs from *recognition*. A value-bearing condition can exist before an accounting system, market, institution, or observer recognizes it. Recognition can itself alter value by changing access, legitimacy, price, or institutional response, but recognition and generation remain analytically distinct. Second, generation differs from *transfer*. A transfer changes the location, control, or incidence of something already represented as valuable, whereas generation changes the conditions through which economically relevant significance becomes newly realizable or expanded. Later sections will examine transmission and transfer directly. Third, generation differs from *capture*. A subject who captures part of a value flow need not be the subject, relation, institution, ecosystem, or collective process through which that value was generated. This distinction is central to the generative-justice lineage, which emphasizes relations between value generation, control over productive conditions, circulation, and extraction (Eglash 2016; Eglash et al. 2024).

Definition 14.8 fixes the term at the level needed for GRE.

Definition 14.8 (Value generation)**.** Within GRE, *value generation* is a historically situated process through which material, capability, relational, epistemic, institutional, participatory, option, future, ecological, financial, or other specified conditions acquire, expand, regenerate, or make practically realizable an economically relevant significance under a stated evaluative standpoint. The concept identifies a generative pathway and its mediating conditions; it does not imply that every generated effect is beneficial, that value is created ex nihilo, or that the resulting value is fully commensurable across forms and affected positions.

Definition 14.8 places the analytical burden on the pathway. A claim that a programme "creates value" is incomplete unless the relevant transformation can be described with sufficient specificity. The source condition can be material, relational, institutional, epistemic, ecological, or mixed. The mediating process can involve labor, learning, coordination, organization, maintenance, experimentation, legal recognition, participation, technological transformation, or ecological regeneration. The resulting significance can take several forms, and its incidence can extend beyond the actor who receives the most visible output. This pathway orientation also permits failed generation to be identified: resources can be consumed without forming the expected capacity; knowledge can be produced without becoming usable; an institu-

Table 14.4: Recurring pathways of value generation in GRE

Pathway	Primary transformation	Value forms commonly implicated	Identification question
Resource transformation	Change in the physical, technical, organizational, or usable state of resources	Material, financial, ecological, capability	Which transformation makes a previously unavailable or less usable condition practically significant?
Capacity formation	Development of effective ability to act, function, produce, learn, participate, or convert resources	Capability, participatory, epistemic, option	Which durable or transferable ability becomes practically exercisable?
Relation formation	Creation or reorganization of economically consequential relations among subjects, entities, or institutions	Relational, institutional, capability, financial	Which relation changes access, coordination, trust, dependence, reciprocity, or joint action?
Knowledge generation	Production of information, warranted understanding, methods, classifications, or learning capacity	Epistemic, capability, financial, institutional	What becomes knowable or interpretable, and under which conditions can that knowledge be used?
Institutional formation	Stabilization of rules, statuses, rights, routines, governance arrangements, or expectations	Institutional, participatory, option, financial	Which durable rule or recognized position changes later feasible action and coordination?
Participation	Expansion of effective standing and capacity to shape production, governance, valuation, or decision	Participatory, relational, epistemic, institutional	Whose agency enters the process, through which channel, and with what practical uptake?
Option generation	Creation or preservation of practically reachable alternatives for later action	Option, capability, future, institutional	Which later pathways become reachable, reversible, or less costly to enter?
Multiscale generation	Coupled generation whose conditions and effects operate across several analytical scales	Potentially several forms	How do local, organizational, regional, national, transnational, or ecological processes reinforce or constrain one another?

tion can be established without acquiring legitimacy; participation can be formally invited without becoming effective.

Table 14.4 summarizes the eight pathways developed below. The rows are analytical entry points rather than mutually exclusive mechanisms. A single generative episode can involve several pathways simultaneously or sequentially.

14.4.1 Resource Transformation

Resource transformation concerns processes in which the physical, technical, spatial, organizational, or usable state of a resource changes in a way that generates economically relevant significance. Its role in the value-generation architecture is to retain the materiality of economic processes without treating raw resource quantity as equivalent to realized value. Transformation can involve production, repair, maintenance, recombination, refinement, adaptation, preservation, logistical repositioning, ecological regeneration, or the integration of complementary resources.

A basic transformation can be represented qualitatively as a change in what a resource can support. Raw material becomes a component; a component becomes part of functioning infrastructure; a vacant building becomes usable workspace after repair and adaptation; data become interpretable after cleaning, documentation, and

linkage; land becomes more productive after ecological restoration or irrigation; an energy source becomes practically usable through a compatible distribution system. The value-generating step lies neither in the original resource alone nor in the final object considered in isolation. It lies in the historically situated process that changes its practical affordances and relations to other conditions.

This perspective preserves a distinction between *transformation* and *mere throughput*. A process can consume material and energy while degrading the resulting conditions, shifting costs elsewhere, or producing outputs whose value depends on unexamined external relations. A short-run financial gain can coexist with ecological depletion, capability erosion, or future maintenance burdens. Resource transformation therefore becomes value generation only relative to a specified evaluative frame and incidence analysis. The same physical process can generate financial value for one organization while reducing ecological value or future option value for other affected positions.

Maintenance deserves particular attention because a production-centered vocabulary can make it analytically secondary. Maintaining a bridge, irrigation system, software stack, laboratory, archive, ecosystem, or care infrastructure can preserve the conditions under which value remains realizable. In some contexts, maintenance generates renewed service capacity by reversing deterioration or adapting an existing resource to changed conditions. GRE can therefore distinguish original production, maintenance, repair, and regeneration without assuming that only the first counts as economically generative.

Resource transformation is also mediated by institutions and knowledge. A physical asset can remain economically inert when the rights to use it are unclear, the necessary skills are absent, safety approval is unavailable, or complementary infrastructure is missing. Conversely, a modest material change can generate substantial value when it resolves a critical bottleneck. The relevant explanatory unit is therefore often a resource-in-relation rather than a resource considered as an isolated stock.

This mechanism provides a first example of why value generation and value measurement should remain distinct. Acquisition cost, market price, replacement cost, physical output, and service flow can each be useful indicators, yet none by itself identifies the full generative pathway. The later valuation section can compare such measures. At the present stage, the analytical requirement is more basic: identify the transformation that changes the practical significance of the resource and the conditions under which that change is realized.

14.4.2 Capacity Formation

Capacity formation concerns processes through which a subject or collective develops an effective ability to act, function, produce, learn, participate, coordinate, adapt, or convert resources. It is distinct from resource transfer because the presence of a resource does not establish the ability to use it. Capability analysis provides an established precedent for this separation by emphasizing what persons are substantively able to do and be rather than inferring opportunity directly from commodities or income (Sen 1985; Sen 1992; Sen 1999). GRE retains that insight while extending attention to relational, organizational, institutional, and collectively held capacities.

Several mechanisms can contribute to capacity formation. Education and training can develop skills; repeated practice can form routines; health and care can preserve bodily capacity; infrastructure can make a skill exercisable; organizational learning can distribute know-how across teams; legal status can make an otherwise latent capability institutionally usable; collective organization can create capacities that no participant possesses alone. Human-capital theory provides one influential economic representation of acquired knowledge and skill as productive investment (Becker 1964). GRE can use such representations where they are adequate while retaining forms of capability that are difficult to reduce to expected earnings or individual productivity.

Capacity formation is temporally structured. Some capacities can be acquired quickly, while others depend on prolonged learning, trust, socialization, institutional continuity, or cumulative practice. The time required for formation can be economically consequential because interruptions, precarious funding, or recurrent institutional turnover can prevent an initially promising resource allocation from becoming a durable capability. A training grant that ends before participants can practice the acquired skill may produce credentials without stable capability. A research infrastructure programme can purchase equipment before a community of competent users forms. Evaluation therefore needs to distinguish resource provision, intermediate learning, demonstrated performance, and durable capacity.

Capacity can also be collective. A research group can acquire the capacity to investigate a problem through complementary expertise, shared methods, data infrastructure, trust, and coordination routines. A community can acquire disaster-response capacity through communication protocols, local knowledge, equipment, and institutional links. A supply network can develop adaptation capacity through redundancy and interoperability. These capacities belong neither to one individual nor to an abstract collective independent of its members; they are realized through organized relations among participants and supporting conditions.

A further distinction concerns capacity expansion and capacity displacement. A new technology can expand one set of abilities while eroding another through deskilling, dependence on proprietary infrastructure, or loss of local knowledge. An institution can professionalize a practice while making participation harder for actors without credentials. Capacity generation should therefore be assessed across affected positions and time horizons. The analytical claim that one capability has expanded does not establish a net positive judgment across heterogeneous value forms.

The generative importance of capacity lies in its recursive potential. A newly formed capacity can become a condition for later generation: literacy supports further learning; scientific competence supports research; organizational capacity supports institution building; technical skill supports adaptation; participatory capacity supports later collective decision. This recursive feature connects capacity formation to the broader GRE concern with generative opportunity developed in Chapter 13. The present section shifts the focus from the allocation of enabling conditions to the process through which those conditions become value-bearing abilities.

14.4.3 Relation Formation

Relation formation concerns the creation or reorganization of economically consequential connections among subjects, organizations, institutions, infrastructures, or other relevant entities. Its importance for value generation follows from a simple observation developed throughout the book: some economically relevant capacities and outcomes exist only through organized relations. Access, coordination, trust, joint production, referral, interoperability, reciprocity, knowledge exchange, and collective action can depend on relations whose formation cannot be inferred from the resources held by participants separately.

Economic sociology provides established support for treating economic action as embedded in ongoing social relations rather than as a sequence of atomized transactions (Granovetter 1985). Relational-work analysis similarly shows that economic transfers are matched to differentiated social relations, media, boundaries, and meanings (Zelizer 2012). GRE draws a narrower implication for value generation: forming or reorganizing a relation can change what participants are able to realize, convert, coordinate, or generate later.

Relation formation can generate value through several mechanisms. A new supplier relation can make specialized inputs available; a referral relation can connect patients to care; a standards consortium can enable interoperability; a research collaboration can combine otherwise separated knowledge; a credit relation can provide financing capacity; a trusted exchange relation can reduce verification and coordination costs; a mutual-aid relation can provide resilience under disruption. These examples differ in institutional form and normative status. What they share is that the value-bearing condition depends materially on the relation itself or on the patterned interaction it makes possible.

Formation should be distinguished from contact. One meeting, transaction, or communication event may begin a relation without stabilizing it. Economically consequential formation often requires repeated interaction, mutual recognition, expectations, compatibility, commitment, or institutional support. The relevant threshold depends on the process. A one-time emergency referral can be sufficient for a particular outcome; a scientific collaboration may require durable shared methods and trust; an infrastructure network may require formal standards and maintenance obligations. GRE therefore treats relation formation as mechanism-specific rather than defining one universal criterion of relational existence.

Relations can also generate asymmetric value. A platform relation can create market access while increasing dependence on platform governance. A financing relation can provide liquidity while creating repayment exposure. An employment relation can generate income, capability, and social connection while allocating authority and risk unevenly. Relation formation should consequently be analyzed together with bargaining position, exit conditions, maintenance burdens, and control over the terms of the relation. The existence of a productive relation does not establish equal incidence of the value it helps generate.

This subsection also clarifies the relation between relational value and value generated through relations. A relation can itself be valued, as in trust, companionship, solidarity, or durable collaboration. It can also function as a generative condition for

other value forms without being the primary object of valuation. A logistics relation can generate material accessibility; a mentoring relation can generate capability and epistemic value; a legal relation can generate institutional standing. Preserving this distinction prevents "relational value" from becoming a catch-all category for every value whose realization happens to involve more than one actor.

14.4.4 Knowledge Generation

Knowledge generation concerns processes through which economically relevant information, explanations, methods, classifications, interpretations, or warranted understandings become available for later action. Its role in the value-generation architecture is distinct from both information transfer and capability formation. Information can be transmitted without producing understanding; a person can possess a capability without generating new knowledge; and knowledge can be produced without immediately becoming economically usable. GRE therefore treats epistemic generation as a process with its own conditions of production, validation, access, interpretation, and uptake.

The economics of invention has long recognized that knowledge production differs from ordinary commodity production because uncertainty and appropriation problems affect inventive activity (Arrow 1962). Later institutional work on knowledge commons emphasizes additional questions of access, enclosure, preservation, intellectual property, and collective governance (Hess and Ostrom 2007). These traditions differ in emphasis, yet both support the limited point required here: knowledge generation has institutional and relational conditions that affect who can contribute, who can access results, how knowledge circulates, and whether it becomes a condition for further generation.

Knowledge can be generated through formal research, experimentation, practical learning, comparison, observation, documentation, interpretation, and distributed problem solving. The output can be explicit, such as a dataset, theorem, protocol, design, or report, or partly tacit, such as situated know-how embodied in skilled practice. The latter case matters because an organization can lose knowledge even when documents remain. Staff turnover, weakened communities of practice, discontinued maintenance, or loss of contextual memory can reduce the practical epistemic value of formally preserved information.

Knowledge generation also has an evidential dimension. A new claim does not acquire the same epistemic standing merely because it has been produced. Methods, provenance, reproducibility, corroboration, interpretive coherence, and domain-specific standards affect whether information becomes warranted or action-guiding. This distinction is particularly important for GRE because epistemic events can influence future decision pathways. A measurement, model, audit, testimony, or experiment can change the relative support for alternative interpretations and interventions without mechanically determining a single response.

The value of generated knowledge can be recursive and distributed. A scientific result can support later discoveries; a public dataset can lower entry costs for multiple users; a documented failure can prevent repetition; a local ecological observation can improve governance; a shared technical standard can support interoperability.

At the same time, knowledge can be enclosed, strategically withheld, rendered inaccessible through technical complexity, or converted into proprietary advantage. Generation and distribution are therefore separate analytical questions. A process can generate substantial epistemic value while concentrating control over its use.

Knowledge generation can also reorganize other value forms. New knowledge can increase the option value of delayed commitment, reduce uncertainty around ecological risk, reveal previously hidden harms, or alter the financial valuation of an asset. Such cross-form effects prepare the later analysis of transmission and conversion. At this stage, the relevant identification question is whether a process produces a new or materially improved epistemic condition and whether the relations needed for interpretation and use are present.

14.4.5 Institutional Formation

Institutional formation concerns processes through which rules, statuses, rights, routines, governance arrangements, recognized categories, enforcement practices, or stable expectations become sufficiently organized to structure later economic action. Institutions can generate value by reducing uncertainty, making commitments credible, defining access, protecting rights, coordinating expectations, stabilizing collective action, or preserving resources across time. North's institutional analysis emphasizes the role of humanly devised constraints in structuring interaction and shaping incentives under uncertainty (North 1990). GRE uses this insight without treating institutional persistence as intrinsically valuable.

The formation of an institution can involve formal legislation or contract, but it can also arise through organizational routines, conventions, shared standards, professional norms, repeated governance practices, or self-organized collective arrangements. Ostrom's studies of common-pool resource governance provide an important empirical precedent for institutions generated through collective action outside a simple market-versus-state binary (Ostrom 1990). The relevant GRE question is not which institutional form is universally preferable. It is how a particular arrangement changes the conditions under which value can be generated, accessed, sustained, contested, or recirculated.

Institutional formation often converts fragile coordination into more durable expectation. A temporary collaboration can acquire governance rules; an informal entitlement can become legally recognized; a recurring practice can become an organizational routine; a technical convention can become a standard; a community initiative can develop procedures for membership, resource use, and conflict resolution. Such stabilization can generate institutional value because later action requires less renegotiation and because participants can plan with greater confidence.

Durability, however, creates path dependence as well as predictability. Institutional formation can privilege particular categories, actors, technologies, or valuation schemes. Once embedded in law, accounting, infrastructure, professional practice, or organizational routines, these arrangements can become costly to revise. An institution that initially generates coordination value can later obstruct adaptation or exclude newly relevant subjects. Value generation through institutional formation should therefore be analyzed together with revisability, contestability, and the

distribution of authority over institutional change.

Institutional value can also be generated through recognition. Legal status can transform a previously informal claim into an enforceable right; accreditation can make competence portable; an organizational form can permit collective ownership or asset holding; a governance procedure can give previously excluded participants standing. Recognition in these cases is performative: the institution does not merely observe an existing condition but changes what actions are authorized and what claims become consequential.

Institutional formation frequently interacts with the other pathways in this section. Knowledge institutions support epistemic generation; participatory rules shape whose knowledge enters decisions; property and contract institutions affect resource transformation; standards shape technical relation formation; educational institutions support capacity formation. This interdependence explains why institutional formation can have multiscale consequences even when the formal rule is adopted at one organizational or jurisdictional level.

14.4.6 Participation

Participation concerns the generation of value through effective involvement in production, governance, inquiry, valuation, design, maintenance, or decision. Its inclusion as a distinct pathway reflects the possibility that participation is both a value form and a mechanism through which other value forms are generated. A subject can value participation because voice, recognition, agency, or membership matters directly; participation can also improve knowledge, legitimacy, capability, coordination, or institutional fit when relevant contributions enter a process.

Effective participation requires more than formal invitation. Standing, information, time, language, accessibility, procedural rights, confidence, material resources, and the likelihood that contributions will receive practical consideration can determine whether participation is usable. Chapter 13 treated these conditions partly through allocation and generative opportunity. The present section asks what can be generated when participation becomes substantively effective.

One mechanism is epistemic. Participants can contribute situated knowledge unavailable to centralized decision makers. Another is capability-forming: repeated involvement can develop skills in deliberation, coordination, technical interpretation, leadership, or collective problem solving. Participation can also generate relational value through trust and mutual recognition, although poorly designed participation can generate conflict or fatigue instead. At the institutional level, participation can improve legitimacy or make rules more responsive to practical conditions. These outcomes are contingent rather than automatic.

Participation can also alter the identity of value generators. In a purely recipient-oriented model, an institution produces a service and others receive it. In participatory production, affected subjects can contribute to defining objectives, methods, standards, or maintenance. Generative-justice work is relevant here because it emphasizes the relation between those who generate value and their control over the conditions and benefits of generation (Eglash 2016; Eglash et al. 2024). GRE does not infer that participation always yields justice. It uses the distinction to ask who is rec-

ognized as a value generator and how participation affects control, incidence, and recirculation.

Participation can become extractive when institutions solicit time, data, cultural knowledge, emotional labor, or community legitimacy without returning meaningful influence or benefit. Formal co-design can leave agenda setting and final authority unchanged. Volunteer participation can substitute unpaid effort for institutional responsibility. Consultation can produce information while keeping decision rights concentrated. A serious value-generation analysis therefore distinguishes participatory input, effective influence, benefit incidence, and control over resulting outputs.

Participation also creates maintenance obligations. Collective governance, open-source communities, cooperatives, research collaborations, and civic institutions require continuing work to sustain communication, documentation, conflict resolution, and renewal of membership. The value generated through participation can dissipate when these maintenance capacities are ignored. Participation is therefore best understood as an organized generative process whose quality depends on both entry and continuity.

14.4.7 Option Generation

Option generation concerns processes that create, preserve, or make practically reachable alternatives for later action. It extends the distinction introduced in Section 14.2.8: option value concerns the significance of reachable alternatives, whereas option generation concerns the process through which those alternatives become available. The difference is analogous to the distinction between a capability and capability formation. A system can possess valuable options because earlier investments, institutional choices, standards, or relations generated them.

Options can be generated through several mechanisms. Interoperable infrastructure can permit switching among providers or technologies. General education can support several later occupational paths. Open standards can allow multiple compatible innovations. A modular research infrastructure can accommodate questions that were not known when it was built. Legal recognition can open access to institutions previously unavailable. Ecological preservation can retain future uses and regenerative capacities that irreversible conversion would foreclose. Financial reserves and organizational slack can create room for response under uncertainty.

Option generation is especially important where the future is uncertain and commitments are partly irreversible. A narrowly optimized arrangement can perform well under expected conditions while leaving little room for adaptation. A somewhat less optimized but modular, redundant, or revisable arrangement can generate a wider range of feasible responses. This does not imply that more options are always better. Maintaining alternatives can consume resources, delay specialization, complicate coordination, or preserve low-value paths. The evaluative question concerns which options matter, for whom, at what cost, and under which uncertainties.

Options also differ in accessibility. A formal alternative that requires unavailable capital, knowledge, permission, language, mobility, or technical compatibility has weak practical significance for the affected subject. Option generation therefore requires attention to conversion conditions. Creating a legal right of exit without cre-

ating a practical alternative provider may generate little effective option value. Publishing open data without usable documentation may create nominal access while leaving entry barriers intact. The pathway is complete only when the alternative becomes sufficiently reachable for the analytical purpose at hand.

Option generation can produce recursive generativity. An option can become a platform for later option creation. A broadly educated population can generate new occupations and institutions; an open technical standard can support unforeseen complementary innovations; a protected ecological corridor can preserve evolutionary and ecological processes whose future significance is unknown. These cases illustrate why option generation is closely related to future value without being identical to it. The generated option is a present structural property of the feasible action space, while the value eventually realized through it can remain uncertain.

This pathway also makes foreclosure analytically visible. When an institution, technology, infrastructure, or contract closes alternatives, the relevant effect is not simply the absence of new generation. It can be a reduction in previously reachable pathways. Later sections on accumulation, extraction, harm, and historical transformation will examine such processes more directly. Here the point is that generating and closing options are distinct mechanisms that can occur simultaneously across different positions.

14.4.8 Multiscale Generation

Multiscale generation concerns value-generating processes whose enabling conditions, mechanisms, and effects are distributed across more than one analytical scale. Its purpose is to prevent local generation from being treated as self-contained when it depends on organizational, regional, national, transnational, ecological, or intergenerational relations. Scale is process-relative: the relevant levels depend on the mechanism rather than on a fixed territorial hierarchy.

A local enterprise can generate employment and capability through national legal institutions, transnational supply networks, digital platforms, public infrastructure, and ecological resources. A national research programme can generate local laboratories, international knowledge networks, and firm-level innovation. A community conservation initiative can depend on regional watersheds, national property law, and global climate conditions. A platform can generate network value at transnational scale while distributing labor, risk, and infrastructure burdens locally. In each case, the generative process cannot be adequately attributed to one scale without examining the relations that connect them.

Cross-scale complementarity is one mechanism. Local capability can become valuable because wider infrastructure makes it usable; national institutions can become effective because local organizations enact them; transnational standards can lower coordination costs while relying on local compliance and maintenance. Cross-scale constraint is another. A locally valuable practice can be undermined by national regulation, international price shifts, ecological change, or concentrated platform power. Conversely, a national policy can have weak generative effect when local institutions lack conversion capacity.

Multiscale generation also affects attribution. Visible value may appear at one

scale while the labor, ecological input, public investment, or institutional support that made it possible lies elsewhere. A profitable firm can draw on publicly funded education and infrastructure; a digital service can depend on distributed data labor and energy-intensive compute; an urban development can generate land value partly through public transport investment; an export industry can generate national income while imposing localized ecological burdens. GRE does not require a single accounting rule for these cases. It requires that claims about generation identify materially relevant cross-scale conditions rather than locating value creation only where the final price or revenue appears.

Temporal scale interacts with spatial and institutional scale. Some generative processes mature over years while others respond quickly; some benefits are local and immediate while costs appear later or elsewhere. A research investment can produce knowledge long before commercial return; institutional capacity can accumulate slowly and then enable rapid coordination during crisis; ecological depletion can remain weakly visible until thresholds are crossed. Multiscale generation therefore includes coupled timescales as well as coupled territorial or organizational scales.

The analytical implication is neither that every value inquiry should trace the entire world-system nor that local explanations are invalid. Scope should follow material relevance. A laboratory study can remain local when wider conditions are stable and analytically secondary. A firm-level capability study can abstract from macroeconomic conditions when the abstraction is justified. The frame should widen when cross-scale dependencies materially alter the explanation of where value comes from, who contributes to it, who can access it, or which burdens accompany it.

Proposition 14.9 states the section's resulting scope rule.

Proposition 14.9 (Pathway-specific analysis of value generation)**.** *A GRE claim that value has been generated is analytically adequate only to the extent required by the inquiry when it identifies the relevant value form and evaluative standpoint, specifies a plausible generative pathway, and preserves materially consequential differences among generation, recognition, transfer, capture, and downstream incidence. Where several pathways or scales jointly condition the result, their interaction should remain visible rather than being compressed into a single undifferentiated source of value.*

Proposition 14.9 does not impose maximal causal reconstruction. Its purpose is to prevent a broad rhetorical claim of "value creation" from substituting for mechanism. Some inquiries can identify a short and well-bounded transformation; others require capacity, relation, institution, knowledge, participation, option, or multiscale analysis. The appropriate resolution depends on the question and the materiality of omitted mechanisms.

The section also clarifies the relation between value generation and the generative-value concept introduced at the close of Chapter 13. Value generation names a process through which specified value-bearing conditions emerge, expand, regenerate, or become realizable. Generative value concerns the significance of processes or conditions that contribute to further generation under an explicit evaluative standpoint. A capability can therefore be generated in the present and later carry generative value because it supports additional learning or collective action. A relation can generate immediate coordination value without producing substantial later generativity.

Keeping these concepts separate allows the analysis to ask first what value is generated, then how it moves, changes form, recirculates, accumulates, dissipates, or contributes to subsequent generative processes.

The next section takes up the first of those questions directly. Once value has been generated or recognized in one position or configuration, its consequences can extend through transfers, transmissions, transformations, and propagation across relations. An adequate account of value therefore requires attention not only to origins but also to the pathways through which heterogeneous value forms travel and change.

14.5 Value Transmission, Transfer, and Propagation

Section 14.4 distinguished value generation from recognition, transfer, and capture and identified several pathways through which value-bearing conditions can be produced or expanded. The role of the present section is to analyze what happens when such conditions move, become available, are reproduced, or acquire effects across positions and relations. Its objective is to distinguish *transfer*, *transmission*, and *propagation*; identify the objects, positions, channels, transformations, and incidence involved; and provide a formal representation that can accommodate heterogeneous value forms without presuming a conserved scalar quantity. The discussion then examines transformation, loss, leakage, return, reciprocity, distributed consequence, justice, unequal transfer capacity, capture, cross-scale movement, and delay. The method is conceptual and mechanism-oriented, with a restrained formal layer used to make provenance, path, type, and transformation explicit.

The economic significance of transmission becomes visible whenever the location of value is insufficient to explain its effective incidence. A financial transfer can be routed through institutions that retain fees or impose conditions. Knowledge can be transmitted without disappearing from its source, yet its usability can depend on language, documentation, trust, and institutional recognition. A credential can travel through a recognition regime while the underlying capability is only partly represented. A technical standard can propagate across organizations and reorganize compatibility, dependency, and future investment. Ecological benefits and burdens can move across territorial boundaries through material flows and delayed system effects. In each case, something economically consequential reaches beyond its initial position, while the mechanism of movement helps determine what becomes available, to whom, in what form, and with which consequences.

GRE therefore treats transmission as a relational process rather than a metaphor of a substance flowing unchanged through a neutral pipe. The relevant channel can translate, certify, filter, transform, delay, amplify, attenuate, gate, or capture what passes through it. The source can remain in possession of the transmitted condition, as in many knowledge processes; the recipient can receive a derivative rather than the source object; intermediaries can acquire value or impose burdens; and downstream positions can be affected without appearing in the formal transfer contract. Analysis should consequently preserve provenance, value form, pathway, institutional conditions, and incidence whenever these are material to the research question.

A further discipline concerns conservation. Financial bookkeeping often supports conservation-like identities within a specified account boundary. Other value forms need not behave similarly. Knowledge can be replicated; trust can strengthen through repeated successful exchange; ecological capacity can regenerate under some conditions and degrade under others; a legal status can enable several parties at once; an institutional rule can propagate by imitation. GRE therefore does not assume that transmitted value is a fixed quantity partitioned among recipients. Quantitative conservation may be imposed locally where the empirical object warrants it, but it is not a general property of heterogeneous value transmission.

Definition 14.10 fixes the principal analytical object used in the section.

Definition 14.10 (Value-transmission episode)**.** A *value-transmission episode* is a bounded reconstruction of a process in which one or more value-bearing objects, conditions, claims, capacities, relations, signals, or recognized representations become available, effective, transformed, redistributed, reproduced, or consequential across specified source, recipient, intermediary, and affected positions through identifiable relational channels over a stated horizon. The reconstruction retains the relevant value form, provenance, path, transformation, and incidence without presuming conservation or complete commensurability.

The word *episode* is deliberately modest. A transmission can be a discrete payment, a recurrent remittance, a multi-stage knowledge-transfer process, a diffusion process across organizations, or a long-horizon ecological consequence. The analytical boundary should be selected according to the process under study rather than inferred from the existence of a transaction record.

Table 14.5 summarizes the main dimensions developed below. The dimensions are separable for analysis but often interact in practice.

14.5.1 Transfer, Transmission, and Propagation

The first analytical task is terminological separation. *Transfer* identifies a bounded reassignment or provision of a value-bearing object, right, claim, access condition, representation, or control position between specified positions. *Transmission* identifies the relational process through which something value-bearing becomes available or effective at another position, potentially through intermediaries and transformation. *Propagation* identifies the extension or reproduction of value-bearing effects across multiple positions, relations, or scales through time. The three concepts overlap, yet each foregrounds a different object of explanation.

A transfer is often the most institutionally visible event. Money moves between accounts; title to an asset changes; a license is granted; data are delivered; a scholarship is awarded; equipment is handed over; a right of access is recognized. Transfer analysis can ask whether the object reached the intended recipient, whether the amount or right was correctly specified, and whether conditions of transfer were satisfied. This level remains sufficient for questions whose practical object is receipt or formal reassignment.

Transmission becomes relevant when effective realization depends on the path. The same dataset can have different epistemic value when accompanied by metadata,

Table 14.5: Analytical architecture of value transmission, transfer, and propagation

Dimension	Analytical object	Characteristic question	Characteristic caution
Process type	Transfer, transmission, propagation	Is the focal event a bounded reassignment, a mediated passage, or an expanding pattern of downstream consequence?	The three processes can coexist in one trajectory
Value form	Material, financial, capability, relational, epistemic, institutional, participatory, option, future, ecological, or another specified form	What form is represented at each point in the path?	Form labels do not establish commensurability
Positions	Source, recipient, intermediary, generator, bearer, affected party	Which positions generate, send, route, receive, transform, or bear consequences?	One actor can occupy several positions
Channel and path	Contract, market, organization, platform, infrastructure, legal regime, language, community, ecological pathway	Through which relation or sequence does transmission occur?	Channels can transform as well as carry
Transformation	Conversion, certification, translation, aggregation, copying, filtering, degradation	What changes while transmission occurs?	Change of form is not automatically loss
Incidence	Direct receipt, indirect benefit, burden, exclusion, maintenance, dependency, spillover	Who or what is materially affected beyond the formal recipient?	Formal transfer boundaries can understate incidence
Governance	Access, rules, gatekeeping, pricing, consent, contestation, exit, return	Who can initiate, block, redirect, condition, or contest transmission?	Control over transmission can become a source of power
Time and scale	Delay, recurrence, latency, local and cross-scale paths	When and at which scales do effects become realized?	Immediate receipt can differ from later consequence

translation, documentation, and institutional authorization. The same payment can support different capacities under different fee structures, delays, currency conversions, or legal restrictions. A technical instruction can become usable only after tacit knowledge, demonstrations, or trusted interpretation are transmitted alongside the text. Transmission therefore includes the mediating relations that connect an origin to practical uptake.

Propagation extends the boundary further. A transmitted practice can be adopted by several organizations; a financial shock can spread through contractual and balance-sheet relations; a legal rule can be copied across jurisdictions; a standard can reorganize compatibility across an industry; knowledge produced in one site can be reused elsewhere and generate further knowledge. Propagation can occur through repeated transfers, imitation, network effects, common infrastructure, institutional diffusion, ecological processes, or higher-order coordination. Network and higher-order representations can be useful where the path and configuration materially affect reach (Wasserman and Faust 1994; Bick et al. 2023).

The distinctions also prevent a misleading metaphor of source depletion. In a transfer of a unique physical asset, receipt by one position can coincide with loss of possession by another. In knowledge transmission, copying may preserve the source while expanding availability. Institutional recognition can sometimes expand access for one position without removing it from another. Relational value can strengthen

through reciprocal use. A generalized model should therefore leave source change as an empirical question rather than building depletion into the definition of transfer.

Transfer, transmission, and propagation can also diverge temporally. A payment may transfer instantly while the capability it supports develops over months. A legal right may be granted now while practical access remains blocked until institutional procedures change. A standard may be transmitted to early adopters and propagate later as complementary investments accumulate. This timing distinction prepares the later analysis of delayed and cross-scale transmission.

14.5.2 Value Forms and Transfer Objects

A value form and a transfer object should be distinguished. Section 14.2 identified several analytical forms of value. A *transfer object* is the carrier, claim, condition, representation, or institutional device through which a value-relevant transmission is organized. The same transfer object can implicate several value forms, while the same value form can be transmitted through different objects.

Money provides a simple illustration. The transferred object can be a monetary claim denominated in a specified currency. Its financial value is immediate, yet its later capability, option, relational, or institutional value depends on conversion conditions. A scholarship payment can finance tuition, expand practical educational access, alter status within an institution, create future options, and change household obligations. Treating the transferred money as identical to the full value trajectory would collapse the distinction between carrier and consequence.

Knowledge offers a different pattern. A report, dataset, software repository, lesson, diagram, demonstration, or conversation can function as a transfer object for epistemic value. Yet the object is not the knowledge in an exhaustive sense. Interpretation can require prior concepts, language, institutional permission, tacit skill, and opportunities for practice. Epistemic value can therefore be carried by an artifact while remaining only partly realizable through the artifact alone.

Rights and statuses can also be transfer objects in a broad institutional sense. A permit, membership, credential, entitlement, recognized claim, or access authorization can reorganize later feasible action. Property-rights analysis illustrates why such objects should not be reduced to a binary owned/unowned variable: access, withdrawal, management, exclusion, and alienation can be distributed among different positions (Schlager and Ostrom 1992). The value transmitted by an institutional status can therefore depend on the bundle of effective rights and on the institutions that recognize them.

Relational value poses a further caution. A relation itself need not be treated as a transferable possession. A referral, introduction, membership, reputation signal, compatibility standard, or shared governance arrangement can transmit conditions that enable relations to form or become effective. The appropriate transfer object is then the access condition, signal, institutional recognition, or resource supporting the relation, rather than a claim that the relation has moved as a substance from one actor to another.

Ecological value similarly resists a simple carrier model. Water, nutrients, pollu-

tants, seeds, energy, carbon, habitat conditions, and ecological functions can move or propagate across space. Their economic significance depends on ecological relations and affected positions. A transfer object can therefore be materially identifiable while its value form and incidence remain distributed and contested.

The analytical implication is a provenance rule: when describing a transmission, identify the object or condition that moves or becomes available and separately identify the value form or forms attributed to it. This discipline reduces the risk of inferring that a change in object location is equivalent to a proportional transfer of every value associated with that object.

14.5.3 Source, Recipient, and Intermediary Positions

Transmission is organized through positions rather than through fixed moral identities. A *source position* is a position from which the focal object, condition, claim, signal, or value-bearing effect enters the bounded transmission episode. A *recipient position* is one at which it becomes available, recognized, effective, or consequential. An *intermediary position* participates in routing, translating, certifying, financing, storing, filtering, aggregating, governing, or otherwise mediating the path. These roles can be occupied by persons, organizations, infrastructures, institutions, platforms, communities, or other analytically specified entities.

The same actor can occupy several positions. A university can receive public funding, intermediate it through departments, generate knowledge, transmit credentials, and later receive donations or reputational returns from graduates. A platform can receive data, mediate access between users, transform information through ranking systems, and capture financial value through advertising. A community organization can receive a grant while also contributing unpaid knowledge, legitimacy, maintenance, and social coordination that become constitutive sources of later value. Source and recipient labels therefore should not be treated as permanent characteristics of actors.

The source can also be distributed. Knowledge may arise from accumulated public research, community practice, prior infrastructure, and several organizations rather than from a single originator. Ecological value can depend on distributed maintenance and inherited natural conditions. Institutional credibility can be co-generated through repeated conduct by many participants. When the generative source is collective, attributing the resulting value to the actor that performs the final transfer can obscure provenance and create later justice problems.

Intermediaries deserve particular attention because mediation can change both form and incidence. A bank can convert, delay, price, and condition a financial transfer. A credentialing institution can translate learning into recognized status. A translator can make knowledge usable across language boundaries. A digital platform can determine visibility and compatibility. A public agency can certify eligibility and route access. These intermediaries can add value through coordination, verification, risk-bearing, interpretation, or infrastructure; they can also become bottlenecks or sites of capture.

Intermediary analysis should therefore distinguish function from entitlement. The fact that mediation contributes to value realization can support a claim that some

resources are required to sustain the intermediary function. It does not by itself determine how much value the intermediary should receive, what control it should exercise, or whether alternatives should remain available. Those questions require an evaluative and institutional framework.

Position analysis also clarifies burden. The position that formally sends or receives a transfer need not be the position that bears maintenance, risk, compliance, ecological cost, or future dependency. Distributed incidence, developed below, therefore supplements the source-recipient-intermediary triad with affected positions that can lie outside the contractual path.

14.5.4 Relational Channels and Transfer Paths

A transmission channel is a relation, institutional arrangement, infrastructure, or repeated mechanism through which a value-bearing object or effect can pass, become recognized, or acquire practical reach. A transfer path is an ordered or partially ordered sequence of such channels connecting relevant positions. The distinction allows GRE to analyze route structure without presuming that social processes always take the form of simple pairwise chains.

Channels can be contractual, organizational, market-based, technical, legal, linguistic, communal, educational, financial, ecological, or mixed. A contract can define rights and obligations; an organization can route budgets and authority; a market can match claims and prices; a platform can mediate discoverability and access; a legal regime can recognize status; a language can enable interpretation; a professional community can validate knowledge; an ecological process can transport material consequences. The channel is therefore part of the causal and institutional architecture of transmission.

Several channel properties can matter. *Accessibility* concerns who can enter or use the channel. *Capacity* concerns the volume, complexity, or diversity it can support. *Reliability* concerns whether expected transmission occurs under specified conditions. *Latency* concerns delay. *Visibility* concerns whether participants and affected parties can observe the process. *Reversibility* concerns whether transmission can be withdrawn, corrected, or redirected. *Governability* concerns who can change the channel's rules. *Transformative intensity* concerns how much the transmitted object or value representation changes along the path.

Paths can be alternative or complementary. A migrant can send money through formal banking, digital payment, or informal networks; scientific knowledge can travel through publication, teaching, software, standards, consultancy, or professional mobility. Alternative paths can increase resilience and bargaining power. Complementary paths can be required together: a legal entitlement may need information, documentation, translation, and local institutional recognition before practical access is realized.

Pairwise graphs can represent many channels, while hypergraphs or other higher-order representations can be useful where transmission depends on a configuration of several participants rather than separable dyads (Wasserman and Faust 1994; Bick et al. 2023). The choice of representation should follow the process. A multilateral guarantee, common infrastructure, consortium, or shared standard can

require a higher-order representation because the transmission condition is jointly constituted.

Path analysis also introduces provenance. A value-bearing effect received at the end of a path can depend on transformations performed upstream. Recording the path helps identify where translation occurred, where claims were certified, where fees were extracted, where loss or leakage emerged, and where responsibility for maintenance or error resides. Provenance becomes especially important when heterogeneous value forms are converted during transmission.

14.5.5 Value-Transmission Formalism

A compact formalism can make the preceding distinctions explicit without reducing them to a common metric. Let P denote a set of represented positions, E a set of represented relational channels, and F a set of value-form labels. For each value form $f \in \mathsf{F}$, let $\mathcal{V}_f$ denote a representation space appropriate to that form. The spaces $\mathcal{V}_f$ need not share units, algebraic structure, or cardinal comparability. A financial representation can use currency units; an epistemic representation can use categories of evidence or competence; an institutional representation can use statuses or rights; a relational representation can use network or qualitative relational properties.

A transmission episode can then be represented by a record containing source position s, a set of recipient positions R, a possibly empty set of intermediaries M, a path or higher-order channel structure p, an input value form f_0, one or more output forms, a contextual state c, and a time interval. Equation 14.1 gives one compact notation.

$$\tau = \big(s, R, M, p, f_0, \mathbf{f}_{\text{out}}, c, [t_0, t_1]\big). \tag{14.1}$$

Equation 14.1 is a bookkeeping representation rather than a causal model by itself. Its purpose is to prevent important elements from disappearing when a transfer is summarized by a source, recipient, and nominal amount. The context c can contain legal status, institutional rules, complementary capacities, language, infrastructure, risk conditions, evaluative standpoint, or other variables justified by the research question.

The formalism remains typed. For a channel $e \in \mathsf{E}$ and context c, a transmission operator from form f to form g can be represented as a partial mapping. Equation 14.2 states the generic form.

$$\mathcal{T}_{e,c}^{g \leftarrow f} : \mathcal{D}_{e,c}^{f} \subseteq \mathcal{V}_f \longrightarrow 2^{\mathcal{V}_g \times \Xi_{e,c}}. \tag{14.2}$$

In Equation 14.2, $\mathcal{D}_{e,c}^{f}$ is the domain in which the channel is practically applicable, $2^{(\cdot)}$ denotes the set of represented subsets of admissible outcomes, and $\Xi_{e,c}$ stores side information such as recipient position, delay, burden, provenance, confidence, or institutional condition. A deterministic model can replace the set-valued output with a single value. A qualitative study can instantiate $\mathcal{V}_f$ through categories rather than numbers. The notation therefore distinguishes formal structure from empirical parameterization.

For an ordered path $p = (e_1, \ldots, e_m)$ with intermediate forms $f_1, \ldots, f_{m-1}$, the path-level representation can be written as a composition when the outputs and domains are compatible. Equation 14.3 records this conditional composition.

$$\mathcal{T}_{p,c}^{f_m \leftarrow f_0} = \mathcal{T}_{e_m,c_m}^{f_m \leftarrow f_{m-1}} \circ \cdots \circ \mathcal{T}_{e_1,c_1}^{f_1 \leftarrow f_0}. \tag{14.3}$$

Equation 14.3 does not imply that every social transmission is literally sequential or that path composition is empirically sufficient. Higher-order coordination, feedback, simultaneous interaction, and changing context can require richer representations. The composition symbol denotes ordinary function composition in a deterministic representation and relational composition in a set-valued representation. The equation therefore provides a transparent baseline for cases in which a staged path is a useful analytical approximation.

The principal advantage of the typed construction is that cross-form transmission does not require addition across unlike values. A financial input can support capability formation, an epistemic signal can change institutional status, or relational trust can reduce the cost of later financial coordination. These transformations can be represented through mappings between distinct spaces while preserving the provenance of each step.

14.5.6 Transmission Operators and Transfer Kernels

Transmission operators represent transformations at the structural level. A *transfer kernel* is appropriate only when the research design supplies a quantitative or probabilistic representation of how an input at one position and time contributes to an output at another position and time. The kernel should therefore be treated as an empirical model class rather than a universal feature of GRE.

Suppose a source representation $x_i^{(f)}(t)$ and recipient representation $y_j^{(g)}(t')$ are measurable in spaces for which a linear integral approximation is meaningful over the chosen domain. A context-dependent transfer kernel can be written as Equation 14.4.

$$y_j^{(g)}(t') = \int K_{ij}^{g \leftarrow f}(t', t \mid c)\, x_i^{(f)}(t)\, \mathrm{d}t + \varepsilon_j^{(g)}(t'). \tag{14.4}$$

In Equation 14.4, $K_{ij}^{g \leftarrow f}$ represents the modeled relation between source and recipient under context c, and $\varepsilon_j^{(g)}$ collects unmodeled contributions and error. If $f = g$ and the units are preserved, the kernel can represent attenuation, delay, or routing. If $f \neq g$, the kernel embeds an explicitly modeled conversion relationship and therefore carries the assumptions, units, and empirical uncertainty of that conversion. It should not be interpreted as a universal exchange rate among value forms.

Kernel models can be useful for financial remittance delays, diffusion of a measurable signal, energy or material transmission, epidemiological-like propagation analogies, or other processes where time and path response can be estimated. Their usefulness depends on data and mechanism. In many institutional, relational, or epistemic settings, qualitative process tracing or a typed graph can be more faithful than a numerical kernel.

Operators and kernels also differ in epistemic status. An operator can function as a structural formalization that records admissible transformations. A kernel typically requires stronger empirical commitments: measurement choices, functional form, stationarity or non-stationarity assumptions, boundary conditions, and parameter estimation. Conflating the two can make a conceptual diagram appear more empirically established than it is.

A further caution concerns feedback. Equation 14.4 is written as a one-way relation for clarity. Actual transmission can change the channel itself: repeated successful transfer can build trust, congestion can reduce capacity, fees can change entry, learning can alter conversion ability, and institutional response can modify eligibility. Dynamic models should therefore allow K or $\mathcal{T}$ to depend on prior transmission history when such path dependence is material.

14.5.7 Heterogeneous Value Transmission

Heterogeneous value transmission is the central case for which a typed formalism is needed. A process can begin with one value form and produce effects in several others without those forms becoming comparable on a common scale. A financial transfer can support capability, institutional, relational, and option value. Knowledge transmission can generate financial returns, institutional recognition, or future options. Ecological restoration can affect material production, future value, and collective capability. The transmission analysis should retain these branches rather than collapse them into a single aggregate by default.

A heterogeneous transmission record should preserve at least five kinds of provenance where they matter: the input value form, the transformation or conversion interface, the output value form, the positions affected, and the evaluative or measurement framework through which the output is recognized. This makes it possible to distinguish a real transformation from a change in measurement language.

The distinction between transmission and conversion is especially important. Transmission concerns how an economically consequential condition becomes available or effective across positions or relations. Conversion concerns a change in value form or representational realization. A payment sent from one account to another can be transmission without cross-form conversion. A credentialing process that converts learning into recognized institutional status can involve conversion even when little geographic movement occurs. Many trajectories contain both.

Commensuration is another separate operation. Converting several effects into a common monetary, index, or scoring metric can support comparison, but the metric is institutionally and methodologically constructed. Research on commensuration and valuation shows that such transformations have cognitive and political consequences and can reorganize the objects being compared (Espeland and Stevens 1998; Fourcade 2011). GRE therefore records commensuration as an analytical act rather than treating a common metric as evidence that heterogeneous values were already naturally homogeneous.

Heterogeneous transmission can also produce non-additive outcomes. A small financial contribution can unlock a large capability effect when complementary infrastructure already exists. Additional information can have little epistemic value when

interpretation capacity is absent. Institutional recognition can create discontinuous access to rights or markets. Relation formation can alter the marginal value of other resources. These interactions caution against inferring downstream value from the nominal magnitude of the initial transfer.

Where a research design requires aggregation, the aggregation rule should state its domain and purpose. A fiscal analysis can legitimately aggregate money; a multicriteria evaluation can normalize several dimensions for a decision procedure; a capability study can use specified indicators. The claim should remain local to that representation. Heterogeneous transmission becomes analytically distorted when a convenient common metric is silently promoted into an ontology of value.

14.5.8 Transformation, Loss, and Leakage in Transfer

Transmission commonly changes what passes through it. *Transformation* is a change in form, quality, usability, institutional status, interpretation, or practical effect. *Loss* is a reduction in the value-relevant property or usable effect relative to a specified purpose and boundary. *Leakage* is a diversion of resources or effects toward positions, uses, or pathways outside the intended or modeled destination. These categories can overlap, but they should not be treated as synonyms.

Transformation can be productive. Translation can make knowledge accessible; certification can convert uncertain information into institutionally recognized evidence; packaging can preserve a material good; intermediation can reduce risk; aggregation can make small contributions usable for infrastructure. A change between source and recipient is therefore not evidence of inefficiency by itself.

Loss requires a reference. Physical spoilage can reduce usable material; currency fees can reduce the amount received; information can be degraded through repeated compression; trust can be lost through breach; a legal right can lose practical effect when procedures become inaccessible. The relevant baseline can be an intended output, a counterfactual path, or a technically defined preservation criterion. Without such a baseline, the label *loss* risks embedding an unstated normative judgment.

Leakage is similarly boundary-dependent. A subsidy spent outside a target region can appear as leakage in a regional programme while remaining income elsewhere. Knowledge intended for one organization can diffuse more widely and create positive external effects. Funds routed through corruption can represent capture from one evaluative standpoint and income to another position, while still violating the governing institutional rules. Analysis should state the intended path and the affected boundary before characterizing an effect as leakage.

Source depletion should also be separated from path loss. A unique asset transferred away from a source can reduce source holdings even if the recipient receives it intact. Knowledge can be transmitted without comparable depletion. Relational attention or caregiving can impose time and emotional burdens on the source even if the recipient benefits. This distinction matters for justice because a highly effective transmission can still be exploitative if the burdens of maintaining it are concentrated on poorly recognized source positions.

Where scalar measurement is appropriate, an efficiency or yield measure can be

defined locally. Such a measure should remain restricted to comparable units and a specified objective. GRE does not generalize a same-form financial transfer ratio into a universal measure of heterogeneous value transmission.

14.5.9 Return, Reciprocity, and Backflow

Transmission need not be unidirectional. *Return* identifies a later flow or effect that reaches a source, generator, maintaining community, or another position specified as entitled to return. *Reciprocity* identifies a relational pattern in which giving, contribution, support, or recognition is met by an expected or practiced response. *Backflow* is a broader descriptive term for reverse-direction consequences, whether beneficial, burdensome, voluntary, institutionalized, or unintended.

Return can occur in the same value form or another one. Financial investment can generate monetary return; community knowledge can receive institutional recognition or infrastructure support; training can return as mentoring; open-source contribution can receive reputation, improvements, or maintenance from later users; ecological stewardship can return through improved material conditions. Cross-form return is common, so reciprocity should not be presumed to require equality of nominal quantities.

Temporal structure matters. Immediate exchange can be reciprocal, but so can long-horizon arrangements in which return is delayed or distributed across different members of a community. A public institution can receive taxes now and provide infrastructure over time. Intergenerational knowledge transmission can create obligations of maintenance or stewardship that are not discharged to the original contributor. The evaluative question concerns the governing relation and the legitimacy of the expected return rather than a mechanical balance at each moment.

Backflow includes negative effects. A recipient can become indebted, surveilled, dependent, or obligated as a condition of receiving a transfer. A technology transfer can send user data, royalties, or technical dependence back to the provider. Financial support can generate reporting burdens or policy conditions. Ecological extraction can return pollution or climate risk to distant or future positions. Reverse-direction effects therefore belong to transmission incidence even when they are absent from the nominal transfer object.

Generative-justice work places particular emphasis on value returning to the people and communities that participate in its generation and on avoiding extractive one-way flows (Eglash 2016; Eglash et al. 2024). GRE adopts this as an important justice question while retaining the need to specify the relevant generators, forms of contribution, governance arrangements, and affected non-human conditions. A circular flow can still reproduce hierarchy if control over the circulation remains concentrated.

Reciprocity also should not be romanticized. A reciprocal norm can sustain mutual aid and trust, but it can also impose coercive obligations, exclude outsiders, or conceal unequal capacity to contribute. Analysis should therefore separate the existence of return from its justice, voluntariness, and effect on future generative opportunity.

14.5.10 Transfer Incidence and Distributed Consequence

Transfer incidence concerns who or what is materially affected by a transmission beyond the positions named in the formal transfer. The concept extends ordinary recipient analysis by tracing direct receipt, indirect benefit, burden, exclusion, maintenance responsibility, dependency, and downstream consequence across the bounded relational configuration.

A transfer can have several incidence layers. The *formal incidence* identifies the legally or administratively recognized sender and recipient. The *effective incidence* identifies positions whose resources, capabilities, constraints, or opportunities change through practical use. The *relational incidence* identifies changes in authority, dependency, trust, coordination, maintenance, or exit. The *downstream incidence* identifies materially relevant effects on later or indirectly connected positions. These layers can coincide, but they often diverge.

Examples are common. A grant to an organization can benefit employees while increasing reporting work for administrators and dependency on a donor. A digital platform subsidy can lower user prices while strengthening the platform's position relative to complementors. Infrastructure investment can benefit connected regions while redirecting traffic or environmental burden elsewhere. A new credential can expand access for holders while raising entry barriers for otherwise capable nonholders. The transfer amount by itself does not reveal these distributed effects.

Causal inference under interference provides one methodological reminder: an intervention assigned to one unit can affect outcomes of other units through contagion, allocation, or other pathways, so unit-level independence should not be presumed where relations create cross-unit effects (Ogburn and VanderWeele 2014). GRE uses this insight as a methodological caution rather than as a claim that all economic transmission should be modeled through a single causal-graph formalism.

Distributed consequence also extends beyond human recipients. Ecological systems can bear material burdens or provide regenerative capacity; future participants can inherit infrastructure, debt, depleted resources, standards, or institutions. Such incidence should be included when it is materially relevant to the value claim and research question.

A complete incidence map is rarely possible or necessary. The depth of tracing should be proportional to plausible materiality. Researchers can define stopping rules through temporal horizon, causal strength, institutional relevance, magnitude, reversibility, vulnerability, or decision usefulness. The purpose is to prevent the administrative boundary of a transfer from silently becoming the boundary of economic consequence.

14.5.11 Justice of Value Transmission and Transfer

Justice analysis enters transmission after the descriptive architecture has identified positions, pathways, transformations, burdens, returns, and control. The role of this subsection is to specify questions that a justice framework can ask without assuming that GRE itself supplies one universal distributive rule. Relevant normative traditions can disagree about equality, sufficiency, rights, freedom, reciprocity, desert,

need, sustainability, recognition, or procedural fairness. GRE contributes a relational map on which those disagreements can be made more explicit.

At least eight questions recur. Who participates in generating the value that enters transmission? Who can initiate or block the transfer? Who controls the channel and its rules? Who receives the focal object or benefit? Who performs translation, maintenance, care, certification, or risk-bearing work along the path? Who bears loss, delay, dependency, or ecological burden? Who can contest, refuse, exit, or redirect the transmission? Who receives return when the transmitted value supports later generation? These questions distinguish distributive position from generative contribution and governance.

Agency is central where transmission affects a person's or community's feasible life. Sen's capability-oriented account emphasizes substantive freedom and the role of social conditions in enabling what persons are effectively able to do (Sen 1999). In transmission analysis, this supports attention to whether receipt expands effective opportunity while preserving the capacity to choose, refuse, convert, or use the transferred condition. A nominally beneficial transfer can have a different normative profile when it is conditional on intrusive control or when recipients lack meaningful alternatives.

Recognition also matters. A transmission can appropriate community knowledge while recognizing only the intermediary that commercializes it. Care, maintenance, translation, or data production can remain economically necessary while being poorly represented in formal value accounts. Generative-justice scholarship directly foregrounds the relation between value generators, circulation, control over productive conditions, and extraction (Eglash 2016; Eglash et al. 2024). GRE uses this lineage to ask whether transmission reproduces the generative source, depletes it, or returns sufficient resources and control for continued generation.

Property and governance arrangements further shape justice. Differentiated rights over access, management, exclusion, and alienation can allocate control over transmission channels even when nominal ownership appears unchanged (Schlager and Ostrom 1992). A community can retain use while losing control over exclusion; users can receive access without voice over terms; an intermediary can gain authority to redirect or monetize a flow. Justice analysis should therefore inspect the bundle of operative rights rather than infer control from a single ownership label.

Context can alter legitimate transmission principles. Nissenbaum's contextual-integrity framework was developed for information privacy, where appropriateness depends on actors, information types, contexts, and transmission principles (Nissenbaum 2010). GRE does not generalize privacy theory into a universal transfer ethic, but the framework offers a useful analogy: the permissibility of moving a value-bearing object can depend on the social relation and governing norm, not only on technical possibility or aggregate benefit.

A justice evaluation should finally consider future generative opportunity. A transfer can improve present welfare while creating dependency that narrows later exit, or it can impose short-run burdens that build shared capacity under legitimate participatory governance. Present distribution and later generative conditions therefore can point in different directions. Making the temporal tradeoff explicit is preferable

to treating either current receipt or future generation as automatically decisive.

14.5.12 Unequal Transfer Capacity and Capture

Actors and institutions differ in their capacity to transmit value. *Transfer capacity* includes the practical ability to initiate, receive, store, translate, certify, route, price, insure, monitor, interrupt, redirect, or contest transmissions. These capacities depend on resources, infrastructure, legal standing, technical standards, language, networks, reputation, data access, organizational scale, and institutional authority. Unequal transfer capacity can therefore shape both who participates in circulation and who controls its terms.

Control over bottlenecks is especially consequential. A position that controls a payment rail, platform, credentialing standard, logistics hub, interoperability layer, legal authorization, or data interface can influence the availability and cost of transmission for many others. Such a position can provide valuable coordination while also acquiring bargaining power. Resource-dependence analysis supplies a relevant precedent for understanding how organizations become constrained by external actors that control important resources and alternatives (Pfeffer and Salancik 1978).

Capture occurs when a position obtains or controls part of a value-bearing flow or its downstream returns in a manner that is analytically distinct from its contribution to generation or necessary mediation. Capture is descriptive before it is normative. A contractual fee, tax, platform commission, licensing payment, rent, or appropriation can all represent capture relative to a specified flow boundary, yet their legitimacy depends on institutions, rights, contribution, bargaining conditions, public purpose, and the chosen justice framework.

Capture can occur at several points. A source can capture value generated by recipients through restrictive licensing. An intermediary can retain a disproportionate share of a flow. A recipient can appropriate shared knowledge without returning maintenance resources. A dominant organization can externalize ecological or care burdens while retaining financial gains. The same transmission trajectory can therefore contain several capture relations in different value forms.

Unequal transfer capacity also affects visibility. Powerful intermediaries can define the categories through which transmitted value is measured, determine which contributions count, and control the data needed to evaluate incidence. This epistemic capacity can reinforce financial or institutional capture by making alternatives harder to demonstrate. Transmission governance should therefore consider auditability, data access, explanation, and contestability where these conditions materially affect power.

A further issue is path dependence. Once a transmission channel becomes dominant, complementary investments can make alternatives costly. Users can accumulate data, reputational capital, credentials, or technical dependencies that are difficult to port. Transfer capacity then becomes self-reinforcing even when the original advantage was modest. Later sections on accumulation, extraction, and historical transformation will develop these dynamics more directly.

14.5.13 Cross-Scale and Delayed Transmission

Value transmission frequently crosses analytical scales and unfolds with delay. A local transfer can enter organizational routines, regional infrastructure, national regulation, transnational supply chains, or ecological processes. Conversely, a global standard or financial condition can reshape local relations through institutional and technical channels. The scale at which a transfer is authorized therefore need not be the scale at which its principal value or burden is realized.

Cross-scale transmission can involve amplification or attenuation. A small local innovation can propagate widely through a standard or network. A large national programme can have weak local effect when institutional conversion capacity is absent. A global price signal can reorganize local production, while local ecological degradation can accumulate into wider system effects. Analysis should identify the coupling mechanism rather than infer cross-scale effect from the magnitude of the initiating event.

Delay introduces a related problem. Financial receipt can be immediate while capability formation takes years. Knowledge transmitted today can become valuable only when a later problem makes it relevant. Infrastructure can generate future option value that is invisible in current utilization. Ecological burdens can remain latent before crossing thresholds. Institutional rules can reshape trajectories gradually as actors adapt expectations and investments. Transmission therefore should be indexed to a horizon appropriate to the mechanism.

The transfer-kernel notation in Equation 14.4 can represent delay where quantitative measurement is justified, but many long-horizon processes require qualitative or scenario-based reconstruction. A delayed effect can be contingent on intervening events, so the analyst should avoid treating temporal distance as evidence of either irrelevance or direct causation.

Cross-scale and delayed transmission also complicate justice. Those who benefit from an immediate transfer can differ from those who bear later maintenance or ecological costs. Future participants can inherit standards, debts, capacities, institutions, or depleted options without having participated in the initiating decision. Conversely, present contributors can build infrastructures or knowledge commons whose largest benefits accrue later. Justice analysis should therefore preserve temporal and scale-specific incidence rather than aggregate all positions into an undifferentiated social total.

Proposition 14.11 summarizes the section's principal scope discipline.

Proposition 14.11 (Typed provenance of value transmission)**.** *Where transmission materially affects the economic interpretation of a value process, an adequate GRE account should preserve the relevant source and affected positions, value-form labels, channel or path structure, transformations, temporal and scalar incidence, and governing conditions. Cross-form transmission does not by itself establish a conserved quantity, a common metric, or normative equivalence among the values represented.*

Proposition 14.11 does not require maximal tracing for routine transfers. A same-currency payment with negligible downstream complexity can be represented by ordinary financial accounting. The proposition applies when mediation, transformation, heterogeneous value, delayed incidence, distributed consequence, or gover-

nance materially changes the question. Its purpose is to prevent a narrow transfer record from silently substituting for a relational value trajectory.

The section also establishes the immediate bridge to the next analytical problem. Transmission can carry a value form unchanged, but many economically important pathways transform one form into another: money into capability, knowledge into institutional recognition, ecological conditions into material production, or relational trust into reduced coordination cost. Such processes require a more focused analysis of conversion interfaces, constraints, loss, and power over conversion. That problem is developed in the following section on value conversion.

14.6 Value Conversion

Section 14.5 developed transmission, transfer, and propagation while preserving heterogeneous value forms and their provenance. The present section isolates a different process: *conversion*, understood as a transformation through which a value-bearing condition represented in one form, register, or practical domain becomes realizable, legible, actionable, or institutionally effective in another. Its role in Chapter 14 is to explain why economic significance can change form without presuming that the source and target are commensurable or that a fixed quantity of value has moved between them. The objective is to distinguish recurrent conversion mechanisms, the interfaces through which they operate, the conditions that enable or block them, and the remainders that conversion can produce. The discussion proceeds through material, financial, capability, epistemic, relational, institutional, and cross-domain conversion before turning to conversion constraints and conversion loss. The method is conceptual and mechanism-oriented, with a limited typed formalism used only to preserve source form, target form, context, and conversion provenance.

Conversion differs from transmission, although the two can occur in one trajectory. A financial payment transmitted between accounts can remain within the same financial form. A credential held by one person can convert prior learning into recognized eligibility without any value-bearing object being transmitted to another position. Transmission concerns passage across positions or relational paths; conversion concerns a change in the form or practical mode through which significance can be realized. Propagation can then extend the converted effect across a wider configuration. These distinctions prevent a single metaphor of “flow” from carrying several analytically different processes.

Conversion also differs from commensuration. Commensuration constructs a common metric or comparative scale across things that were previously represented differently (Espeland and Stevens 1998). Conversion can occur without such a metric. A legal entitlement can become institutional access, tacit knowledge can become an organizational routine, or trust can reduce coordination costs without requiring the source and target to be assigned a common numerical unit. Conversely, a commensuration procedure can compare two conditions without converting either condition into the other. Monetary valuation often combines both processes, because it can construct a common financial representation and thereby open new exchange or budgeting possibilities, but the analytical distinction should remain visible (Fourcade 2011).

Definition 14.12 fixes the core term used in this section.

Definition 14.12 (Value conversion)**.** A *value conversion* is a historically and relationally situated transformation through which a value-bearing object, capacity, relation, claim, status, representation, ecological condition, or other economically significant configuration becomes realizable, legible, actionable, or institutionally effective in a value form, practical register, or domain different from the one in which the relevant source significance was represented. Conversion preserves provenance between source and target while leaving open whether the transformation is partial, reversible, lossy, value-generating, contested, or quantitatively measurable.

Definition 14.12 treats conversion as typed and conditional. The source condition can remain economically significant after conversion, be altered by the process, or be depleted. The target condition can represent a transformed expression of the source, a newly generated capacity, an institutional recognition, or a mixed result co-produced with complementary conditions. A conversion claim therefore should not be read as proof that source and target are equivalent.

A second concept identifies the practical location at which conversion becomes possible.

Definition 14.13 (Conversion interface)**.** A *conversion interface* is a relational, institutional, technical, legal, epistemic, material, linguistic, or organizational arrangement through which a specified source form can become effective in a specified target form under stated conditions. An interface can enable, filter, price, certify, authorize, translate, restrict, redirect, or block conversion, and can itself become an object of governance and power.

The interface can be a market, licensing regime, credentialing body, bank, platform, standards system, procurement procedure, translation practice, laboratory, school, court, community institution, ecological process, or combination of several arrangements. Its significance lies in the transformation it makes possible and in the terms under which that transformation occurs. Control over the interface can therefore matter even where the controller did not generate the source value.

Table 14.6 summarizes the conversion pathways developed below. The categories identify analytical entry points rather than mutually exclusive processes; a single episode can involve several conversions in sequence or in parallel.

The typed value spaces introduced in Section 14.5 permit a compact representation of conversion without requiring a common scalar value. For source form f, target form g, interface k, and context c, a conversion map can be represented as Equation 14.5.

$$\mathcal{C}_{k,c}^{g \leftarrow f} : \mathcal{D}_{k,c}^{f} \subseteq \mathcal{V}_f \longrightarrow 2^{\mathcal{V}_g \times \Omega_{k,c}}. \tag{14.5}$$

In Equation 14.5, $\mathcal{D}_{k,c}^{f}$ is the subset of source representations for which the interface is practically applicable, while $\Omega_{k,c}$ stores conversion-side information such as provenance, eligibility, delay, burden, remainder, uncertainty, rights, or affected positions. A deterministic quantitative model can specialize the set-valued map where evidence supports it; a qualitative inquiry can use categories or ordered descriptions. The formal object therefore records a typed transformation and its conditions rather

Table 14.6: Analytical architecture of value conversion in GRE

Pathway	Characteristic source–target relation	Typical conversion interface	Characteristic analytical risk
Material	Material condition becomes usable capability, output, infrastructure, ecological condition, or financial claim	Production process, logistics, maintenance system, technical standard, ecological process	Treating physical transformation as sufficient evidence of realized value
Financial	Financial representation enables or represents another value form, or another form becomes financially legible	Market, price system, budget, insurance, credit, accounting, compensation rule	Equating monetization with complete valuation
Capability	Resource, knowledge, relation, or institution becomes effective ability to act or function	Education, health system, infrastructure, complementary resource, organizational routine	Inferring capability directly from nominal resource possession
Epistemic	Data, experience, knowledge, testimony, or practice becomes interpretable or recognized evidence	Research method, classification, credential, peer community, documentation, translation	Losing tacit, contextual, or minority knowledge during formalization
Relational	A relation or relational quality becomes coordination, access, reputation, trust, obligation, or another usable condition	Network, membership, referral, repeated interaction, governance arrangement	Reifying or commodifying the relation itself
Institutional	Claim, practice, achievement, resource, or relation becomes recognized right, status, rule, or organizational capacity	Law, certification, registration, standards, administrative procedure	Confusing formal recognition with effective realization
Cross-domain	Significance represented in one social domain becomes actionable in another	Legal, educational, political, ecological, technical, or economic boundary institution	Erasing domain-specific meanings and normative constraints

than asserting that unlike value forms share a universal numerical structure.

14.6.1 Material Conversion

Material conversion concerns processes in which a physical, ecological, spatial, or technically embodied condition becomes effective in another value form or practical register. Its role differs from the resource-transformation pathway developed in Section 14.4.1. Resource transformation asks how material states are changed in ways that generate significance. Material conversion asks how a material condition becomes usable as capability, financial value, institutional asset, ecological function, option value, or another specified form.

A building can become productive workspace only when physical structure is combined with location, safety, utilities, legal permission, accessibility, and organizational use. A machine can become capability when trained operators, maintenance, energy, and compatible workflows exist. Land can become collateral after legal title and financial recognition are established. Water, soil, biodiversity, or energy can become material input to production while retaining ecological significance that is not exhausted by the productive use. Material conversion therefore commonly requires complementary conditions rather than a direct one-to-one transformation.

Material conversion can remain within a materially defined domain. Raw material can become a component, a component can become infrastructure, and infrastruc-

ture can become a maintained productive system. In such cases the conversion language is useful when the practical significance or institutional status changes, while ordinary physical transformation may be sufficient when the research question concerns only material processing. GRE does not require every technical transformation to be redescribed as a value conversion.

The interface often distributes control. Ownership of a physical resource does not guarantee access to the technical, legal, logistical, or organizational conditions required to use it. A household can possess a computer without reliable connectivity or software access. A community can possess land while lacking infrastructure or recognized rights to develop it. A firm can own equipment while depending on a proprietary standard or external maintenance provider. Conversion capacity can therefore be separated from possession.

Material conversion can also alter the source condition. Extractive production can convert ecological and material conditions into financial or commodity value while degrading the ecological source. Repair can convert financial and labor inputs into restored material functionality. Recycling can recover some material significance while requiring additional energy and infrastructure. These cases show why conversion analysis should retain the condition of the source after conversion rather than represent only the target output.

The material case also cautions against a conservation metaphor for value. Physical conservation laws can apply to matter or energy under specified scientific models, while economically relevant value can appear, disappear, or change through organization, scarcity, access, institutional recognition, and use. GRE therefore does not infer conservation of value from conservation of physical quantities.

14.6.2 Financial Conversion

Financial conversion concerns transformations between financial representations and other value forms. One direction converts financial resources into material, capability, relational, epistemic, institutional, option, or ecological conditions. The other direction makes a non-financial condition financially legible through pricing, collateralization, capitalization, compensation, insurance, accounting, or another monetary representation. The two directions should be distinguished because their interfaces, remainders, and governance can differ substantially.

Financial resources can support other value forms because money is institutionally accepted across many exchange settings. Income can finance housing, education, transport, care, equipment, time, or insurance. Investment can support research, infrastructure, or organizational capacity. A grant can finance knowledge generation and participation. These conversions depend on prices, market availability, legal eligibility, complementary skills, timing, and institutional access. Equivalent nominal amounts can therefore generate different target value across positions.

Conversion into financial representation raises a different problem. A house can acquire a market price, an ecosystem can be represented through a compensation schedule, knowledge can become a royalty-bearing asset, projected earnings can be capitalized, or future claims can be securitized. Such representations can make heterogeneous conditions comparable and actionable within budgeting, exchange, lit-

igation, finance, or policy. Commensuration scholarship emphasizes that common metrics reorganize attention and comparison rather than merely reveal pre-existing equivalence (Espeland and Stevens 1998). Fourcade's analysis of monetary valuation of nature likewise shows that the translation into monetary terms is socially organized and can feed back into the practices being valued (Fourcade 2011).

Financial conversion can therefore be generative as well as reductive. Pricing can support exchange where bilateral qualitative comparison would be difficult. Insurance can convert uncertain exposure into a premium and contractual protection. Credit can convert an expected future repayment capacity into present purchasing power. Financial accounting can coordinate investment across large organizations. At the same time, the financial representation can omit relational, ecological, participatory, or historical dimensions that remain economically significant.

The relevant question is consequently not whether monetization is intrinsically valid or invalid. It is which dimensions are preserved, which are compressed, which become newly actionable, who controls the representation, and what institutional consequences follow. A monetary value can be locally adequate for a transaction or compensation rule while remaining inadequate as an exhaustive representation of the source condition.

Financial conversion also need not be reversible. Selling land and later spending the proceeds on land does not necessarily reconstruct the same ecological, spatial, cultural, or relational configuration. Monetizing community knowledge and later returning money to the community need not restore control over the knowledge or reproduce the relation through which it was generated. Reversibility must therefore be demonstrated rather than inferred from the existence of a market price.

14.6.3 Capability Conversion

Capability conversion concerns transformations through which resources, knowledge, health, infrastructure, relations, rights, or institutional conditions become effective abilities to act, function, produce, learn, participate, maintain, coordinate, or pursue valued possibilities. The capability tradition provides a direct precedent for separating resource possession from what persons are actually able to do and for emphasizing personal, social, and environmental conversion factors (Sen 1999; Robeyns 2005). GRE retains that discipline while extending the analytical object to collective, organizational, relational, and generative capacities where the research question requires them.

Capability conversion is often complementary. A financial resource can support education only when learning opportunities, time, language, prior preparation, transport, and institutional access are available. Information can become practical competence through training and repeated use. A legal right can become effective capability when subjects know the right, can invoke it, can reach the responsible institution, and can withstand the costs of enforcement. Infrastructure can become collective capability when maintenance, governance, technical skill, and coordination are present.

The source and target can both be capabilities. Technical competence can become organizational problem-solving capacity when teams, authority, and communication systems permit its use. Individual expertise can become collective capacity through

documentation, mentoring, standards, and role design. A community's capacity for mutual support can become emergency-response capacity when communication, resources, and institutional recognition are assembled. Such conversion is neither guaranteed nor reducible to aggregation of individual skills.

Capability conversion can be blocked by constraints that are weakly visible in resource accounts. Disability, discrimination, incompatible schedules, language barriers, care obligations, legal status, geographic distance, inaccessible interfaces, or organizational hierarchy can prevent nominal resources from becoming effective ability. These conditions can also differ within the same formally defined group. Conversion analysis therefore requires attention to situated heterogeneity rather than assuming a representative recipient.

Conversion can generate dependency as well as capability. Training tied to proprietary software can increase productive ability while deepening dependence on the vendor. A mobility subsidy can expand access while requiring continued participation in a platform. A credential can expand employment options while making later access dependent on periodic recertification. Capability gains and dependency effects should therefore be traced together when both are materially relevant.

The evaluative standpoint also matters. A capability valued by an employer can differ from the capability valued by a worker or community. Increased capacity to perform a task can improve productivity while reducing autonomy if the surrounding institution intensifies surveillance or work pace. GRE therefore does not treat capability conversion as automatically beneficial; it identifies the effective ability generated and leaves its normative evaluation explicit.

14.6.4 Epistemic Conversion

Epistemic conversion concerns processes through which data, observation, experience, testimony, tacit skill, models, classifications, or knowledge become interpretable, credible, actionable, institutionally recognized, or practically useful in another epistemic or non-epistemic register. The conversion can occur within inquiry, across communities of practice, or at an interface between knowledge and institutional action.

Several distinct conversions are common. Data can become evidence through a research design and interpretive framework. Evidence can become an institutional decision input through standards of admissibility or professional judgment. Tacit practice can become documentation or a training protocol. Experience can become testimony, a case record, or a coded variable. Scientific findings can become a technical standard or policy rule. Learning can become a credential that is recognized outside the setting in which the learning occurred.

These conversions require more than information transfer. The receiving context needs interpretive capacity, concepts, language, trust, and institutional procedures. A dataset can be transmitted perfectly while failing to become knowledge. A report can be understood while lacking standing in a court or regulatory process. Community knowledge can be highly reliable in practice while remaining excluded from a formal evidence hierarchy. Conversion interfaces therefore include epistemic authority as well as communication.

Formalization can enable reach while producing remainder. Standardized measures permit comparison, aggregation, audit, and coordination, yet they can compress contextual distinctions. Rankings illustrate a further possibility: the converted representation can become reactive, changing organizational behavior because actors respond to the measure itself (Espeland and Sauder 2007). The conversion is then performative in a limited empirical sense: the representation participates in reorganizing the field it was intended to describe.

Epistemic conversion also interacts with recognition and power. Institutions can decide which credentials, methods, languages, publication venues, data formats, or evidential standards count. Actors positioned at these interfaces can influence whose knowledge becomes actionable and which forms remain invisible. A conversion analysis should therefore identify not only the source information and target representation, but also the authority that validates the conversion and the opportunities to contest it.

Loss is not inevitable, and standardization can generate new epistemic value. Shared vocabularies, open metadata, interoperable data formats, replication standards, and translation practices can make knowledge usable across settings. The analytical task is to identify what becomes possible through the conversion while retaining the provenance and dimensions that do not survive the transformation.

14.6.5 Relational Conversion

Relational conversion concerns transformations through which a relation, relational position, or relational quality becomes practically significant in another value form or through which another value form materially reorganizes a relation. The concept should be used carefully because a relation is not thereby treated as a detachable commodity. The analytical object is the change in what the relation enables, constrains, signals, or organizes.

Trust can convert into lower monitoring costs, willingness to extend credit, tolerance for uncertainty, or capacity for joint action. Reputation can convert past relational experience into future access. Membership can convert affiliation into information, opportunity, institutional standing, or mutual support. A referral can convert a relation into an opportunity to enter another network or organization. Repeated collaboration can convert relational familiarity into coordination capability.

The reverse direction also matters. Financial investment can stabilize a partnership, while contractual incentives can alter trust. Institutional recognition can convert an informal relation into a formal partnership with rights and obligations. Shared infrastructure can convert geographically dispersed actors into a durable coordination network. A change in ownership can convert a cooperative relation into a hierarchical one. Conversion therefore can modify the relation itself rather than merely extract an output from it.

Relational conversion is often position-specific. The same network can provide access to one participant, surveillance exposure to another, and brokerage power to a third. A relation that reduces transaction costs for insiders can create exclusion for outsiders. Trust can support cooperation while increasing vulnerability when one side has weak exit options. The value converted from a relation should therefore

be indexed to position and incidence rather than represented as a property of the relation alone.

A further distinction concerns relational depletion. Monetizing, formalizing, or instrumentalizing a relation can sometimes alter the qualities through which it generated value. Informal mutual aid converted into paid service can increase reliability and professional capacity while changing reciprocity or meaning. A community relationship converted into a marketing asset can generate financial value while weakening control by community members. The possibility of such transformation does not make formalization inherently harmful; it establishes a reason to track the source relation after conversion.

Relational conversion can also remain only partly legible. Some effects can be represented through network position, frequency of interaction, contractual status, or observed coordination, while trust, obligation, legitimacy, or shared meaning can require qualitative evidence. GRE therefore allows mixed representations rather than forcing relational conversion into a single metric.

14.6.6 Institutional Conversion

Institutional conversion concerns transformations through which claims, practices, achievements, resources, relations, or expectations acquire recognized status within a rule-governed arrangement. It includes the movement from informal to formal recognition, from normative claim to enforceable right, from learning to credential, from possession to recognized title, from technical practice to standard, and from collective aspiration to organizational rule. The target form can then influence later access, authority, transferability, accountability, and coordination.

Recognition is central but does not exhaust the process. A rule can recognize a claim while leaving practical enforcement weak. A credential can certify a capability while only imperfectly representing actual competence. Registration can make an organization legally visible while providing little operational capacity. Institutional conversion therefore has at least two dimensions: symbolic or legal recognition and the practical consequences enabled by that recognition.

Property provides a clear illustration because the institutional form can distribute distinct rights rather than convert possession into one undifferentiated status. Schlager and Ostrom distinguish positions defined by different bundles of access, withdrawal, management, exclusion, and alienation rights (Schlager and Ostrom 1992). A material resource can therefore be institutionally converted into several configurations of authority and obligation. The economic consequences depend on the operative bundle and on the institutions capable of enforcing it.

Certification and standardization create similar interfaces. A skill can become recognized professional eligibility. A manufacturing practice can become compliance with a standard. Data can become auditable evidence when formatted according to an accepted protocol. These conversions can enlarge portability and coordination, yet they can also create gatekeeping positions. Actors who define the categories, evidential rules, standards, or fees can influence which source conditions become institutionally legible.

Institutional conversion can be recursive. Once a classification is established, actors can reorganize behavior to satisfy it; successful compliance can reinforce the category; organizations can invest in capabilities that make the recognized status easier to obtain; alternative forms can decline because they lack institutional portability. Conversion interfaces can therefore become part of the historical process through which value forms are stabilized.

Formal recognition can also crowd out informal arrangements or render them less visible. A recognized professional role can displace community expertise; a standardized contract can simplify exchange while excluding customary obligations; a formal measure can become the dominant basis for funding. Whether this represents improvement, loss, or mixed transformation depends on the evaluative framework and affected positions. Institutional conversion should consequently be analyzed as an intervention into a relational field rather than as neutral labeling.

14.6.7 Cross-Domain Conversion

Cross-domain conversion concerns transformations in which significance constituted or represented within one social domain becomes actionable within another. The concept is useful where economic processes depend on legal, educational, political, ecological, scientific, technical, cultural, or other institutional domains that cannot be reduced to economics without loss of explanatory structure. GRE uses cross-domain conversion to analyze the interface while preserving disciplinary and normative remainders.

A legal entitlement can convert into economic access when institutions recognize and enforce it. Educational achievement can become labor-market eligibility through credential systems. Scientific knowledge can become industrial capacity through standards, licensing, engineering, and organizational learning. Political recognition can become budgetary priority. Ecological conditions can become financial claims through insurance, compensation, ecosystem-service valuation, or carbon-market institutions. Economic resources can in turn become political access, educational opportunity, legal representation, or scientific capacity.

Such conversions are rarely direct. They pass through boundary institutions and categories that translate one domain's objects into another domain's actionable terms. A court can translate a harm claim into damages; a university can translate learning into a credential; a regulator can translate scientific evidence into a compliance requirement; a bank can translate legally recognized assets into collateral value. Each interface selects dimensions that the receiving domain can process.

Selection can generate productive coordination. Cross-domain conversion allows institutions with different internal logics to cooperate without becoming identical. Scientific evidence can inform policy while remaining scientific evidence; law can structure markets without becoming a price system; education can prepare people for work without being reducible to labor-market signaling. The interface can therefore preserve some domain distinctions while establishing a usable connection.

Cross-domain conversion can also create distortion when the receiving domain becomes the sole criterion for the source. Educational value can be reduced to earnings, ecological value to price, scientific value to immediate commercial return, or

legal rights to cost-benefit quantities. These conversions can be useful for bounded decisions while becoming misleading if treated as exhaustive. GRE's low-coupling principle applies conceptually as well as structurally: an interface should connect domains without implying theoretical identity.

Normative constraints can limit conversion. Some rights may be treated as non-tradable; some knowledge can be restricted by confidentiality, community governance, or safety; ecological thresholds can constrain monetization; democratic authority cannot be inferred from purchasing power alone. Cross-domain conversion is therefore partly constituted by rules about what may, may not, or should only conditionally be converted.

14.6.8 Conversion Constraints

Conversion constraints determine where a proposed source–target transformation is practically defined, affordable, authorized, credible, reversible, or socially acceptable. Their role is not merely to reduce an otherwise automatic conversion rate. Constraints help constitute the domain of conversion itself. Equation 14.5 therefore uses a partial domain $\mathcal{D}^{f}_{k,c}$ rather than presuming that every source state in $\mathcal{V}_f$ can be converted through every interface.

Several classes of constraint recur. *Complementarity constraints* require other resources, skills, infrastructure, or relations. *Threshold constraints* require a minimum credential, scale, quality, legal status, or technical specification. *Capacity constraints* limit the amount or complexity an interface can process. *Institutional constraints* concern rights, eligibility, authorization, jurisdiction, or procedural recognition. *Epistemic constraints* concern information, interpretive competence, uncertainty, or credibility. *Spatial and temporal constraints* concern location, timing, duration, latency, or sequencing. *Normative constraints* concern rights, consent, protected values, or limits on acceptable commodification and exchange.

Constraints can be distributed unevenly. Two actors holding similar financial resources can face different prices, documentation burdens, language barriers, collateral requirements, geographic access, or institutional trust. Two organizations with similar knowledge can differ in their capacity to obtain certification or scale a practice. Two communities can possess similar ecological resources while having different legal authority over use. Conversion inequality can therefore persist even where source resources appear equal.

Power becomes especially relevant where actors control a conversion interface. A bank can decide what counts as collateral; a credentialing body can determine which learning becomes recognized qualification; a platform can determine which attention becomes monetizable; a regulator can decide which evidence satisfies a standard; a legal institution can determine which claims become enforceable. Such control can supply necessary coordination while also affecting bargaining positions, access, and the distribution of conversion benefits and burdens.

Conversion capacity can itself be accumulated. Organizations can build legal teams, data systems, reputational capital, technical standards expertise, networks, or financial reserves that make future conversion easier. Actors with repeated access to the interface can learn how to navigate it. Historical success can produce

credentials or collateral that facilitate later conversions. The resulting advantage can become self-reinforcing even before the accumulation mechanisms analyzed in Section 359 and later sections are considered directly.

Constraints are also dynamic. Technological change can lower translation costs; new law can authorize previously unavailable conversions; institutional reform can broaden recognized credentials; infrastructure can make distant markets accessible; social movements can alter which forms of value receive recognition. A blocked conversion at one historical moment can become feasible later, while a formerly easy conversion can disappear when institutions or ecological conditions change.

A conversion analysis should therefore record the interface, domain conditions, complementary requirements, gatekeepers, costs, delays, uncertainties, and possibilities for contestation or alternative paths. This profile is often more informative than a single estimated conversion coefficient because it identifies the structure through which conversion succeeds or fails.

14.6.9 Conversion Loss

Conversion loss concerns economically relevant dimensions of a source condition that are destroyed, compressed, excluded, rendered inaccessible, externalized, or made difficult to recover through conversion. The term requires care because a difference between source and target is not automatically a loss. Transformation can generate new value, and dimensions that disappear from one representation can remain present elsewhere. A claim of loss should therefore identify the standpoint, the source dimension, and the mechanism through which it ceases to remain available or effective.

Several forms of loss can be distinguished. *Representational loss* occurs when a richer source is compressed into a narrower category, score, price, or credential. *Functional loss* occurs when a capability or resource loses some practical use during transformation. *Relational loss* occurs when conversion weakens trust, reciprocity, autonomy, membership, or another economically consequential relation. *Institutional loss* occurs when previously recognized rights or practices disappear under a new classification. *Ecological loss* concerns depletion or degradation of regenerative conditions. *Option loss* concerns foreclosure of later alternatives. *Distributional loss* occurs when a conversion that increases aggregate or recipient value shifts burdens or removes access for other positions.

Loss should also be distinguished from transfer and capture. If one actor loses control because another receives it, the process can be a redistribution rather than dissipation. If an intermediary appropriates value that remains economically active, capture can be a more accurate description. If knowledge is standardized but the unstandardized source remains accessible, the standardized representation contains a remainder without necessarily destroying the original. Precise terminology matters because the practical responses differ.

Conversion can be non-reversible even when a reverse interface exists. In a deterministic special case, let $\mathcal{C}_{a,c}^{g \leftarrow f}$ represent a forward conversion and $\mathcal{C}_{b,c'}^{f \leftarrow g}$ an attempted reverse conversion. Path dependence is represented when the round trip does not reproduce the original state, as stated in Equation 14.6.

$$\mathcal{C}_{b,c'}^{f \leftarrow g}\left(\mathcal{C}_{a,c}^{g \leftarrow f}(x)\right) \neq x. \tag{14.6}$$

Equation 14.6 is a model-specific representation rather than a universal law. It applies where deterministic maps are a useful approximation and where the forward and reverse operations are defined. The analytical point can be expressed qualitatively when formalization is inappropriate: monetizing an ecosystem and later financing restoration need not reconstruct the prior ecosystem; converting tacit practice into a standardized procedure and later discarding the procedure need not restore the lost practice community; converting land into a highly specialized built environment can narrow later uses even if redevelopment remains technically possible.

A *conversion remainder profile* can record what does not survive or become represented in the target form. The profile can include untransformed source dimensions, burdens generated by the interface, affected positions, uncertainty, reversibility, and any newly generated value. This approach avoids forcing heterogeneous losses into one numerical deficit. Where a common unit is empirically justified, a quantitative loss measure can still be used locally, but the broader profile should remain available when qualitatively different dimensions matter.

Conversion loss can also be governed. Documentation can preserve provenance; interoperability can reduce technical lock-in; participatory design can identify meanings that a standardized interface would otherwise omit; legal safeguards can protect rights during institutional conversion; ecological restoration requirements can address material depletion; portability and exit rights can reduce relational or platform dependence. The feasibility and adequacy of these measures depend on the conversion architecture rather than on conversion in the abstract.

The section's analysis can be condensed into Proposition 14.14.

Proposition 14.14 (Conversion provenance and remainder)**.** *Within a GRE value analysis, a conversion claim is adequately specified only to the extent required by the research problem when it identifies the source form, target form, conversion interface, materially relevant enabling and constraining conditions, affected positions, and any remainder whose omission would alter interpretation or evaluation. Such specification does not imply complete commensurability, reversibility, scalar conservation, or normative desirability of the conversion.*

Proposition 14.14 supplies a scope principle rather than a demand for maximal description. A routine currency exchange can be analyzed with a narrow financial representation when other effects are immaterial. A conversion involving ecological depletion, institutional gatekeeping, community knowledge, capability dependence, or contested rights requires a wider frame when those dimensions materially affect the question. The adequate level of detail follows the mechanism and decision problem.

The section also completes the distinction among the processes developed so far in Chapter 14. Generation concerns how value-bearing conditions become produced or expanded. Transmission concerns how they pass across positions and paths. Propagation concerns how effects acquire wider reach. Conversion concerns how significance becomes actionable in another form, register, or domain. These processes can occur together without becoming interchangeable. Their interaction prepares the

next section, which turns to recirculation and asks how converted and transmitted value can return to, maintain, or transform the conditions of later generation.

14.7 Value Recirculation

Sections 14.4–14.6 distinguished value generation, transmission, propagation, and conversion. The present section examines a further process: *recirculation*, in which value-bearing conditions produced, transmitted, used, or converted in an earlier phase re-enter the conditions of later maintenance, regeneration, coordination, or generation. Its role in Chapter 14 is to explain how value trajectories can acquire recursive structure without assuming conservation, closed cycles, or a return to an unchanged origin. The objective is to distinguish return flows, reinvestment, recursive generation, self-sustaining cycles, institutional and community recirculation, cross-scale recirculation, and transformation through recirculation. The method is conceptual and mechanism-oriented. It preserves heterogeneous value forms and historical provenance while using the language of cycles only where the relevant return path and re-entry mechanism can be identified.

Recirculation is narrower than repetition and broader than literal return. Repetition occurs whenever a similar transaction, activity, or transfer happens again. A return flow moves a value-bearing condition, benefit, burden, claim, resource, or transformed output toward a prior source position, contributing relation, or generative setting. Recirculation requires a further relation: the returned or redirected condition must become materially relevant to a later process of maintenance, regeneration, coordination, or generation. Financial revenue that returns to a producer and finances later production is one familiar case. Knowledge produced through practice and returned through documentation or training can be another. Trust generated in successful collaboration can lower the coordination burden of later collaboration. Ecological nutrients can re-enter a regenerative process. The recurring structure can therefore involve different value forms and need not resemble a closed monetary circuit.

The generative-justice literature provides an important precedent for treating circular value flow and return to human and non-human communities of generation as a substantive analytical and normative concern (Eglash 2016; Eglash et al. 2024). GRE inherits this concern while separating several processes that can otherwise be merged under the image of circulation. Recirculation can maintain a productive arrangement, reproduce an unequal dependency, restore depleted conditions, generate new capabilities, amplify a concentration process, or redistribute value across scales. The existence of a recursive path therefore does not establish that the path is just, regenerative, self-sustaining, or normatively desirable.

Definition 14.15 fixes the term used throughout this section.

Definition 14.15 (Value recirculation)**.** A *value recirculation* is a historically situated process in which a value-bearing condition, transformed output, realized benefit, burden, right, capability, relation, representation, ecological condition, or other economically significant result from an earlier phase re-enters the same or a related generative configuration as a materially relevant condition of later maintenance, regen-

Table 14.7: Analytical architecture of value recirculation in GRE

Mechanism	Characteristic re-entry	Typical enabling condition	Characteristic analytical risk
Return flow	Earlier output or benefit moves toward a contributing or prior position	Traceable pathway, entitlement, contract, reciprocity, governance rule	Treating physical return as evidence of regeneration
Reinvestment	Realized value is committed to future productive or generative conditions	Retained control, budgeting authority, time horizon, viable project	Equating expenditure with successful capacity formation
Recursive generation	Earlier generated conditions become inputs to further generation	Complementarity, learning, reuse, cumulative capability	Attributing later outcomes to one initiating episode
Self-sustaining cycle	A recurrent process reproduces materially relevant enabling conditions	Maintenance, replenishment, governance, bounded external dependence	Mistaking boundary-relative sustainability for autonomy
Institutional	Rules, revenues, knowledge, legitimacy, or capacity re-enter institutional reproduction or revision	Durable organization, procedures, memory, authority	Confusing institutional persistence with institutional value
Community	Benefits, capacities, knowledge, or resources re-enter a community of generation or use	Participation, local control, trust, commons governance, access	Romanticizing community or obscuring internal asymmetry
Cross-scale	Value generated or realized at one scale re-enters processes at another	Translation, fiscal links, infrastructure, multilevel institutions	Losing incidence or provenance across scale transitions
Transformative	Recirculation changes the rule, relation, or configuration through which later cycles occur	Learning, institutional revision, changed technology, collective action	Treating a changed cycle as simple reproduction

eration, coordination, conversion, or generation. Recirculation preserves the provenance of the earlier process while leaving open whether the returning condition has changed form, recipient, scale, meaning, or normative status.

Definition 14.15 makes re-entry the central criterion. A payment that returns to an originating account but is immediately removed from the relevant process can be a return flow without recirculation. Conversely, a capability generated in one organization can later re-enter a wider professional or community network without returning to the original institutional recipient. A cycle can therefore close functionally while remaining open geographically, institutionally, or formally. Recirculation should be traced through the generative configuration that the return helps maintain or transform, not solely through identity of sender and recipient.

Table 14.7 summarizes the principal analytical distinctions developed below. The rows are overlapping mechanisms. One empirical process can contain several forms of recirculation simultaneously.

14.7.1 Return Flows

A return flow is the most immediate building block of recirculation. It concerns a movement of resources, rights, information, benefits, responsibilities, recognition, or other economically significant conditions toward a position or configuration that contributed to an earlier process. The return can be contractual, customary, recip-

rocal, institutionally mandated, technically generated, ecologically mediated, or historically emergent. Its analytical significance lies in the relation between the earlier contribution and the later return, rather than in a presumption that the two are equivalent.

Financial examples are familiar: revenue can return to a firm, dividends to investors, tax receipts to a public authority, royalties to creators, or repayments to lenders. Yet return flows also operate outside financial form. Research findings can return to participants or practitioners whose activity generated the underlying evidence. Training can return accumulated organizational knowledge to later cohorts. Maintenance work can return functional capacity to an infrastructure system. Recognition can return status or visibility to contributors. Ecological restoration can redirect resources toward the environmental conditions from which productive activity depends.

The recipient of the return need not be identical to the original generator. A community can contribute knowledge that becomes commercialized, while a later return is directed through a community institution. Workers can generate organizational knowledge that returns through improved tools or training rather than direct payment. Public investment can generate an innovation that later produces tax revenues returned to a broader population. Such cases require a clear account of the relation linking source contribution, intermediate transformation, and return incidence.

Return also need not reproduce the original value form. Financial resources can return as infrastructure, legal support, educational opportunities, or ecological restoration. Knowledge can return as institutional reform. Relational trust can return as reduced monitoring or greater discretion. These are converted returns. Their adequacy therefore depends partly on the conversion interfaces analyzed in Section 14.6. A financial return cannot simply be assumed to compensate for ecological or relational depletion, and a symbolic acknowledgment cannot automatically substitute for control, access, or material benefit.

Return flows can be asymmetric. Some participants can receive early, liquid, or enforceable returns while others receive delayed, conditional, symbolic, or uncertain ones. Intermediaries can retain control over the route of return. Contractual rights can coexist with weak practical access. A return analysis should therefore identify timing, form, recipient, control, burden, and conditions of realization rather than treating return as a binary event.

The presence of a return flow is also insufficient to establish recirculation. The returned condition must re-enter a later relevant process. A dividend used for unrelated consumption is a return to an investor, yet it may have no recirculatory role in the original productive configuration. Revenue retained for maintenance, research, worker training, or replenishment does re-enter later generation. This distinction prepares the analysis of reinvestment.

14.7.2 Reinvestment

Reinvestment concerns the deliberate commitment of realized value-bearing conditions to the maintenance, renewal, expansion, or transformation of future generative capacity. Financial reinvestment is one important case, but GRE uses the concept

more broadly when an earlier result is intentionally redirected into later enabling conditions. Time can be reinvested in training; knowledge in documentation; institutional credibility in coalition building; ecological surplus in restoration; relational trust in more demanding forms of collaboration.

Reinvestment differs from expenditure by its temporal and generative relation to later capacity. An organization can spend revenue on activities that exhaust the available resource within the current period. Reinvestment directs some part of the realized value toward conditions expected to remain relevant to later production, coordination, learning, maintenance, participation, or option generation. The distinction is empirical and purpose-relative. A wage payment can be current expenditure from the firm's accounting perspective while contributing to workers' later capability and household reproduction. A maintenance budget can preserve existing capacity rather than expand it, yet preservation can still constitute reinvestment where continued function depends on renewal.

The effectiveness of reinvestment depends on conversion conditions. Financial resources allocated to research do not automatically become knowledge; a training budget does not automatically become capability; a restoration fund does not automatically regenerate an ecosystem. Reinvestment therefore should be traced through the relevant conversion interface and complementary conditions. Expected generative effects can fail because of poor timing, missing expertise, institutional obstruction, incompatible infrastructure, ecological thresholds, or capture by actors positioned along the path.

Control over reinvestment is itself economically significant. The actor who generated value, the actor who receives the return, and the actor authorized to decide its subsequent use can be different. Shareholders, managers, workers, communities, governments, platforms, foundations, and other institutions can hold different rights over reinvestment. This distribution of authority shapes which generative conditions are replenished and whose future options are expanded. A high rate of reinvestment can therefore coexist with weak return to some generators if the reinvested assets remain under concentrated control.

Reinvestment can also be defensive. Resources can be redirected to repair degradation, satisfy regulatory requirements, replace depreciated assets, restore trust, or maintain rights that would otherwise lapse. Such reinvestment can be essential to continuity even when it produces little visible expansion. GRE therefore distinguishes gross additions from net regeneration and from maintenance of conditions whose deterioration would otherwise narrow later action space.

A further issue concerns horizon. Short-horizon reinvestment can favor rapidly measurable outputs, while slower capability, ecological, institutional, or relational regeneration may require sustained commitments. The temporal-allocation analysis developed in Chapter 13 is therefore relevant to recirculation. A recirculatory architecture can appear productive over one cycle while depleting the conditions required over a longer horizon.

14.7.3 Recursive Generation

Recursive generation occurs when a condition generated in one phase becomes an input to a later generative process. The later process can reproduce a similar form of value, generate a different form, or alter the conditions under which future generation occurs. Recursive generation therefore links recirculation to the pathways developed in Section 14.4: capability can generate further capability, knowledge can generate knowledge and institutional change, relations can enable new relations, and institutional capacity can create the conditions for later collective action.

Learning provides a direct illustration. An activity produces experience; experience becomes knowledge; knowledge is documented, shared, or embodied in routines; those routines improve later activity; later activity generates further experience. The sequence is recursive when outputs from earlier activity materially shape the next generative episode. The same logic can operate in technological development, apprenticeship, organizational learning, community governance, ecological restoration, and research infrastructures.

Recursive generation is history-dependent. The input to a later cycle is rarely identical to the output of the preceding one. Knowledge can be selected and reframed; capital goods depreciate; institutions reinterpret rules; participants enter or leave; environments change; capabilities deepen or become obsolete. A recursive path therefore creates a trajectory rather than a perfect loop. Historical order matters because later generation occurs in a configuration already modified by earlier cycles.

Positive recursion is only one possibility. Dependency can reproduce dependency; exclusion can reduce capabilities needed for later participation; extraction can deplete ecological or relational conditions and make subsequent generation more costly. Recursive processes can thus amplify negative as well as positive conditions. A general theory of recursion should not build desirability into the mechanism.

Attribution also becomes more difficult as recursion continues. A later outcome can depend on many previous cycles, intervening decisions, external shocks, and newly generated conditions. It is therefore inappropriate to attribute the entire later result to a single initiating investment or transfer unless the evidence supports such a claim. Provenance can record historical contribution without implying exclusive causation.

Recursive generation can also broaden the set of agents able to generate value. Training can create trainers; open tools can create new developers; institutional learning can distribute competence beyond an original expert group; community governance can create participants able to sustain the institution. Such recursion is particularly important when generative capacity itself becomes distributed. It also raises questions about control: wider capacity can coexist with centralized ownership of the interface through which that capacity becomes economically effective.

14.7.4 Self-Sustaining Cycles

A self-sustaining cycle is a bounded recursive configuration that reproduces a materially relevant set of its own enabling conditions across repeated phases without requiring continual external replenishment of those same conditions at the level necessary

to keep the process viable. The term is deliberately boundary-relative. Economic and ecological processes remain embedded in larger systems, and few practical arrangements are literally independent of external energy, institutions, knowledge, law, or material inputs.

This bounded definition prevents an overly strong interpretation of self-sufficiency. A community enterprise can cover operating costs and reproduce local capabilities while still depending on national infrastructure and law. An open-source project can reproduce technical knowledge and participation while relying on external hardware, income, or platform access. An ecosystem can regenerate biomass within a local cycle while depending on climatic and hydrological conditions beyond the chosen boundary. Self-sustaining therefore describes a specified recursive property of a modeled system, not autonomy from the wider world.

Several conditions commonly support self-sustaining cycles. The process needs mechanisms for maintenance and repair; replenishment of depleted inputs; renewal or transmission of knowledge; governance of access and burdens; retention or return of sufficient value; and adaptation when the surrounding environment changes. A cycle that produces high visible output while failing to reproduce any one of these enabling conditions can remain viable temporarily yet deteriorate over a longer horizon.

The distinction between a self-sustaining and a self-reinforcing cycle is also useful. A self-sustaining cycle reproduces conditions sufficient for continuation. A self-reinforcing cycle changes the process so that some effect becomes progressively stronger. The two can coincide, but neither implies the other. Stable cooperative maintenance can remain self-sustaining without producing cumulative growth; a speculative financial cycle can be self-reinforcing while becoming increasingly unstable.

A further distinction concerns externalized support. A cycle can appear self-sustaining because maintenance costs, ecological burdens, care work, or knowledge production are borne outside the represented boundary. Such omitted inputs should be restored to the analysis when they materially affect the claim. This is especially important for claims of circularity: material reuse within one organizational boundary can coexist with upstream extraction or downstream waste elsewhere.

Self-sustaining cycles can also reproduce unequal structures. An institution can successfully reproduce its revenues, authority, expertise, and membership while excluding affected groups from decision-making. A platform can reproduce network participation while concentrating control. A debt relation can reproduce repayment capacity while maintaining dependence. Sustainability of the cycle and justice of the cycle are therefore separate evaluative questions.

14.7.5 Institutional Recirculation

Institutional recirculation concerns processes through which value generated or realized through an institution returns to the rules, capacities, knowledge, legitimacy, resources, or relational arrangements that sustain or revise later institutional action. Institutions can recirculate financial resources through budgets, knowledge through records and professional routines, legitimacy through successful performance, capa-

bility through training, and participatory value through procedures that reproduce collective competence.

Organizational memory is one important mechanism. Experience from earlier cases can be encoded in procedures, databases, precedents, standards, or informal repertoires. These representations shape later decisions and reduce the need to reconstruct knowledge from the beginning. Their recirculatory role depends on accessibility, interpretation, revision, and actual use. Accumulated records that cannot be retrieved or questioned do not provide the same institutional capacity as living memory embedded in practice.

Institutional recirculation can also operate through revenue and authority. Tax systems can convert economic activity into public revenue that finances infrastructure, education, administration, or social protection, which can in turn affect later economic activity. Membership organizations can use dues to sustain common services. Cooperatives can retain surplus for shared assets or distribute it according to governance rules. Foundations can convert endowment returns into repeated grantmaking. In each case, the relevant analysis includes both the return channel and the rule governing re-entry.

Rules themselves can recirculate learning. Monitoring can reveal implementation problems; complaints can identify exclusion; judicial review can reinterpret rights; periodic evaluation can change standards; participatory processes can modify priorities. An institution capable of using these epistemic events can convert earlier experience into later institutional change. Institutional recirculation therefore can be reproductive or transformative.

Persistence alone is insufficient evidence of beneficial recirculation. Institutions can recirculate routines that preserve ineffective or exclusionary arrangements. Organizational success can increase legitimacy and resources even where the underlying effects are harmful to some positions. Conversely, an institution can intentionally interrupt an inherited cycle when historical experience shows that continuation would reproduce harm. Recirculation analysis should therefore track what is reproduced, for whom, under whose authority, and with what possibilities for revision.

Institutional recirculation also affects resilience. Redundant knowledge, reserves, trusted procedures, and distributed competence can allow an organization to survive shocks. Yet excessive closure can reduce learning from outside and turn recirculation into institutional insulation. A viable institutional cycle often combines internal reproduction with selective permeability to new evidence, participants, and external conditions.

14.7.6 Community Recirculation

Community recirculation concerns the return and re-entry of resources, capabilities, knowledge, authority, infrastructure, recognition, or other value-bearing conditions into a community that materially participated in generation, stewardship, use, or maintenance. The concept is especially relevant where value generation depends on shared knowledge, common resources, local relations, cultural practices, ecological stewardship, or collective infrastructures that are weakly represented by individual ownership accounts.

The generative-justice literature places particular emphasis on circular value flows that return benefits and control to the communities of generation (Eglash 2016; Eglash et al. 2024). The commons literature likewise documents institutional arrangements through which communities can organize rules, monitoring, sanctions, and collective action around shared resources without reducing governance to a simple choice between centralized state control and individualized privatization (Ostrom 1990). GRE uses these literatures as important precedents while keeping the empirical architecture open: community recirculation can involve money, knowledge, rights, infrastructure, ecological restoration, participation, or several forms together.

Community return should be distinguished from geographic localization alone. A firm can spend money locally while retaining external control over key assets and decisions. A research project can hire local staff while exporting data and knowledge. A platform can distribute income to users while maintaining unilateral control over rules and information. Recirculation becomes more substantial when returned value supports conditions through which community members can maintain, regenerate, govern, or transform their own participation in the relevant process.

Internal heterogeneity also matters. Communities contain differences in authority, wealth, gender, age, expertise, legal status, and access. A return to a community institution can be captured by a narrow group or distributed through unequal procedures. Community recirculation therefore should be traced to internal incidence rather than romanticized as automatically inclusive. Governance arrangements, transparency, contestation, and practical access can be as important as the magnitude of the return.

Knowledge provides a particularly clear case. Community-generated knowledge can be documented and then returned in inaccessible technical form, or it can be translated into tools, educational resources, legal support, and governance capacity that community members can use. The second process has a stronger recirculatory structure because epistemic value re-enters the community's later generative conditions. Similar distinctions apply to cultural symbols, genetic resources, local ecological knowledge, and user-generated data.

Community recirculation can also extend beyond restitution. A return flow can create new collective capacities, new institutions, and new cross-community relations. In such cases the returning value changes the community's later option space rather than simply restoring an earlier condition. This possibility becomes important in the final subsection on transformation through recirculation.

14.7.7 Cross-Scale Recirculation

Cross-scale recirculation occurs when value generated, transmitted, converted, or realized at one analytical scale re-enters generative processes operating at another. The relevant scales can be individual, household, organizational, community, regional, national, transnational, ecological, technical, or institutional. The analytical task is to preserve the pathway and incidence across the scale transition rather than treating value as if it moved unchanged between levels.

Public finance supplies one familiar architecture. Economic activity at dispersed local or organizational sites can generate taxable income; national revenue can finance infrastructure, education, transfers, research, or local governments; those ex-

penditures can affect later local and national economic activity. The process is cross-scale because generation, collection, decision, and re-entry occur at different levels. Its evaluative significance depends on distribution, conversion, timing, and control, not merely on the existence of fiscal circulation.

Knowledge can circulate similarly. Local experiments can generate evidence; organizations or research institutions can aggregate and interpret it; standards or policy can emerge at a wider scale; revised rules then return to local practice. The return can support coordination, but it can also erase local distinctions if aggregation becomes excessive. Cross-scale epistemic recirculation therefore requires attention to both learning and representational remainder.

Ecological processes often cross administrative scales. Local production can affect watershed, regional, or atmospheric conditions; wider regulatory or restoration arrangements can then change incentives and material conditions at local sites. Infrastructure networks likewise connect local use to regional investment and national standards. In such cases recirculation through one scale can impose burdens on another, making scale-specific incidence essential.

Cross-scale recirculation can alter bargaining positions. A community may generate data or ecological value that becomes economically significant at a global scale while receiving limited return. Conversely, transnational revenue, technology, or legal recognition can strengthen local institutions. Intermediaries that translate between scales can perform necessary coordination while acquiring considerable control over value pathways. Their role should be evaluated through function, authority, burden, and capture rather than presumed either parasitic or neutral.

Scale transitions also introduce delay. Value can take years to return through infrastructure, education, institutional reform, or ecological regeneration. The relevant causal chain can therefore span several political, organizational, or market cycles. Cross-scale recirculation analysis should preserve these temporal structures, especially when short-term accounting makes long-horizon return weakly visible.

14.7.8 Transformation through Recirculation

Recirculation can reproduce an existing generative configuration, and it can also transform the configuration through which subsequent cycles occur. Transformation through recirculation arises when returning value changes a relation, rule, capability, technology, institution, evaluative practice, ecological condition, or allocation architecture that structures later generation. The next cycle then begins from a materially different configuration.

Learning is one mechanism. A cooperative project can return experience into governance rules, changing how later decisions are made. Revenue can finance technology that changes the production process. Community returns can establish an institution that did not previously exist. Ecological restoration can alter later resource constraints. New knowledge can revise a standard, which then changes what counts as acceptable evidence or practice. In each case, the recirculatory path modifies its own future pathway.

Transformation can increase or reduce openness. Recirculation can broaden

participation, distribute capacity, create new options, and diversify future pathways. It can also produce lock-in: accumulated returns can finance proprietary infrastructure, deepen dependence on a platform, standardize one technical trajectory, or strengthen an institution's control over conversion interfaces. A cycle can thus become more capable while becoming less revisable.

The value form can transform as well. Financial return can become capability, capability can become knowledge, knowledge can become institutional authority, and institutional authority can create later financial or relational value. A recirculatory trajectory can therefore move through several typed conversions before re-entering generation. The provenance discipline developed in Sections 14.5 and 14.6 is essential for tracing these transformations without treating the changing forms as a conserved quantity.

Transformation also complicates comparison across cycles. If the generative rule changes, later outcomes cannot be evaluated simply as more or less of the same process. The relevant questions may shift from output magnitude to participation, resilience, option space, ecological condition, or institutional control. Historical evaluation therefore needs to identify whether the repeated process remains sufficiently similar for direct comparison or has become a qualitatively different configuration.

A recirculatory analysis should also preserve exits and interruptions. Some cycles should be repairable, some should be transformable, and some may warrant termination when they reproduce severe harm. Designing for recirculation does not require preserving every return path indefinitely. Reversibility, contestation, and alternative channels can prevent recursive arrangements from becoming self-protecting structures that are difficult to revise.

The scope principle of this section is stated in Proposition 14.16.

Proposition 14.16 (Recirculation provenance and transformation)**.** *Within a GRE value analysis, a recirculation claim is adequately specified to the extent required by the research problem when it identifies the earlier value-bearing condition, the return or redirection pathway, the configuration into which that condition re-enters, the materially relevant conversion and incidence along the path, and any transformation of the generative conditions produced through repeated re-entry. The existence of a recursive path does not by itself establish conservation, self-sufficiency, regeneration, justice, or normative desirability.*

Proposition 14.16 protects both explanatory scope and epistemic restraint. A simple reinvestment problem can be analyzed narrowly when the return path and later capacity are well specified. A community, ecological, institutional, or cross-scale recirculation problem requires a wider frame when conversion, internal distribution, externalized support, delayed effects, or transformation materially alter interpretation. The appropriate level of complexity follows the mechanism being studied.

The section also locates recirculation within the broader value-process architecture of Chapter 14. Generation concerns production or expansion of value-bearing conditions. Transmission and propagation concern passage and reach. Conversion concerns transformation across forms or domains. Recirculation concerns re-entry into later generative conditions. These processes can create recursive trajectories whose repeated operation produces accumulation, concentration, depletion, or struc-

tural change. The next section therefore turns to value accumulation and concentration, where repeated generation and recirculation become historically cumulative rather than being analyzed one cycle at a time.

14.8 Value Accumulation and Concentration

Sections 14.4–14.7 examined generation, transmission, conversion, and recirculation. The present section addresses a further historical property of value processes: their effects can become cumulative. Its role in Chapter 14 is to distinguish *accumulation*, in which value-bearing conditions persist, expand, combine, or become available to later processes, from *concentration*, in which control, access, realization, or command over such conditions becomes more unevenly located across positions. The objective is to develop accumulation in relational, capability, epistemic, institutional, self-reinforcing, and intergenerational forms while preserving the heterogeneous value architecture established earlier in the chapter. The method is conceptual and mechanism-oriented. It uses historically situated precedents from political economy, capability analysis, institutional economics, and path-dependence research without treating any one scalar measure of wealth, capital, knowledge, or power as exhaustive of cumulative economic advantage.

Accumulation has a long place in political economy. Classical treatments connected the accumulation of stock or capital to production, division of labor, investment, class relations, and the reproduction of economic arrangements (Smith 1776; Marx 1867). GRE retains the importance of material and financial accumulation while widening the analytical field to value-bearing conditions whose cumulative significance may be relational, capability-based, epistemic, institutional, participatory, ecological, or option-related. This widening does not imply that these forms are equivalent to capital in the same theoretical sense. It means that processes can leave historically inherited conditions that alter what later actors can do, access, generate, convert, or contest.

Concentration is analytically distinct. A value form or generative capacity can accumulate broadly while remaining widely distributed; it can also become concentrated even when its aggregate amount changes little. Contemporary work on firm concentration, for example, shows that productivity and market reallocation can coexist with increasing sales concentration under specified sectoral mechanisms (Autor et al. 2020). GRE therefore treats cumulative quantity, realized capacity, distribution, control, and access as separate dimensions unless the empirical representation justifies collapsing them.

Definition 14.17 and Definition 14.18 fix the two principal terms.

Definition 14.17 (Value accumulation)**.** A *value accumulation* is a historically situated process through which specified value-bearing conditions persist, expand, combine, become more capable of later realization, or become inherited by subsequent phases of an economic configuration. Accumulation is indexed to a value form, subject or collective, relational configuration, evaluative standpoint, and historical interval; it does not require a universal scalar measure across heterogeneous forms.

Definition 14.18 (Value concentration)**.** A *value concentration* is a historically situ-

Table 14.8: Analytical architecture of value accumulation and concentration in GRE

Cumulative process	Characteristic object	Typical mechanism	Characteristic analytical risk
General accumulation	Material, financial, relational, capability, epistemic, institutional, ecological, or option-bearing condition	Persistence, retention, reinvestment, learning, recombination, recirculation	Treating heterogeneous accumulation as one conserved stock
Concentration	Control, access, command, realization, or decision authority	Unequal capture, scale effects, gatekeeping, differential returns, exclusion	Inferring concentration directly from aggregate growth
Relational accumulation	Trust, reputation, reciprocal obligation, network access, coordination channel	Repeated interaction, brokerage, durable cooperation, recognition	Counting ties without examining quality, direction, or dependence
Capability accumulation	Skills, practical freedoms, organizational competence, conversion capacity	Learning, complementary investment, experience, infrastructure	Treating resources or credentials as realized capability
Epistemic accumulation	Knowledge, data, models, credibility, memory, interpretive capacity	Research, documentation, feedback, training, cumulative evidence	Equating stored information with usable or reliable knowledge
Institutional accumulation	Rules, routines, authority, legal standing, organizational memory	Precedent, standardization, repeated procedure, durable organization	Equating institutional persistence with institutional value
Self-reinforcing advantage	Relative position in access, capability, recognition, or control	Increasing returns, feedback, complementarity, switching costs, expectations	Treating path dependence as deterministic inevitability
Intergenerational accumulation	Assets, capabilities, relations, institutions, ecological conditions, liabilities	Inheritance, education, care, law, infrastructure, environmental transmission	Reducing inherited advantage or burden to financial bequest alone

ated change through which control, access, realization, decision authority, or economically consequential command over specified value-bearing conditions becomes more unevenly located among a relevant set of positions. Concentration is therefore a relational distributional property rather than a synonym for aggregate accumulation.

The two definitions allow the analysis to separate cumulative growth from distributional structure. A region can accumulate infrastructure while access to key facilities remains concentrated. Knowledge can accumulate across a scientific field while data, compute, publication channels, or recognition remain controlled by a small set of institutions. A household can accumulate financial assets while losing relational or ecological conditions on which future well-being depends. A public institution can accumulate expertise while decision authority becomes more distributed through procedural reform. These cases differ because accumulation concerns historically inherited value-bearing conditions, whereas concentration concerns how access or control is distributed across positions.

Table 14.8 summarizes the principal cumulative mechanisms developed below. The rows can overlap within a single empirical process.

14.8.1 Accumulation

Accumulation concerns the historical carrying-forward of economically consequential conditions. Its minimal structure contains an earlier condition, a persistence or

generative mechanism, and a later configuration in which the earlier condition remains materially relevant. The inherited condition can be larger in quantity, more capable in use, more connected, more institutionally recognized, or more readily convertible than before. Accumulation therefore concerns cumulative economic capacity in a broad sense while preserving distinctions among the forms through which that capacity is realized.

A stock-flow vocabulary can be useful for some accumulation problems. Financial balances, physical inventories, installed infrastructure, or reproducible capital can often be represented as stocks affected by inflows, outflows, depreciation, investment, and revaluation. GRE does not discard such models. It limits their scope. Trust, institutional legitimacy, tacit capability, recognized standing, ecological resilience, or option space can have cumulative properties without behaving like additive physical stocks. A stock representation should therefore be used where the measured object and aggregation rule are defensible rather than as the default ontology of accumulation.

Accumulation can proceed through several mechanisms. Direct retention preserves resources or rights across time. Investment converts current resources into later capacity. Learning changes what a subject or organization can do. Repeated interaction can build relational reliability. Institutionalization can stabilize authority, memory, or procedure. Recirculation can return earlier outputs to later generative conditions. Ecological regeneration can rebuild conditions that support subsequent production or life. These mechanisms can complement one another, which makes cumulative processes capable of changing both magnitude and structure.

Accumulation also includes liabilities and burdens when they persist into later configurations. Debt, maintenance obligations, ecological depletion, technical lock-in, institutional rigidity, or accumulated distrust can shape future action just as inherited assets and capabilities do. Whether these conditions count as positive or negative value depends on the evaluative standpoint developed in Section 14.1; their cumulative economic relevance can be analyzed before that normative judgment is settled.

Historical sequence matters. Two positions with similar current resources can have different accumulated capacities because one also possesses established relations, learned routines, institutional recognition, complementary infrastructure, or a longer record of successful conversion. Conversely, a large nominal stock can coexist with weak practical capacity when maintenance has been deferred, legal access is insecure, skills are absent, or institutions block conversion. Accumulation should therefore be analyzed through the conditions that make inherited value-bearing states practically consequential.

The relation to recirculation is especially close. Recirculation describes re-entry into later generative conditions; accumulation describes the cumulative historical condition that can result when such re-entry, retention, or generation persists across episodes. A recurring return can maintain a stable level, rebuild a depleted condition, or produce cumulative expansion. Recirculation therefore does not imply accumulation, while accumulation can arise through recirculation when the returning process leaves a progressively different inherited configuration.

14.8.2 Concentration

Concentration concerns the distribution of economically consequential command, access, or realization across relevant positions. A concentrated configuration places a larger share of a specified value-bearing condition, decision right, conversion capacity, or control interface in fewer positions relative to the analytical population. The relevant population can be households, firms, organizations, regions, states, platforms, professions, or another bounded set. The object and denominator should be stated because concentration can look different when measured at different scales.

Financial and market concentration are familiar cases, but GRE extends the question to heterogeneous forms. Control over infrastructure, data, compute, standards, legal expertise, research facilities, credentialing authority, distribution channels, or institutional recognition can be concentrated even where financial ownership is dispersed. Conversely, wealth can be financially concentrated while some public infrastructures, educational capabilities, or epistemic resources remain broadly accessible. The analytical object must therefore be identified before a concentration claim is interpreted.

Concentration can arise through deliberate allocation, cumulative returns, economies of scale, network effects, institutional gatekeeping, legal privilege, differential risk-bearing capacity, mergers, inherited advantage, or repeated successful conversion. It can also arise from functional specialization. A highly specialized scientific facility or emergency capability may be concentrated because duplication is costly or coordination benefits are large. Concentration therefore does not carry a fixed normative status. Its evaluation depends on access, accountability, redundancy, resilience, contestability, externalities, distributional incidence, and the consequences of control.

The distinction between ownership and control is important. A value-bearing asset can have dispersed formal ownership while practical control is concentrated through voting rights, management authority, technical architecture, contractual structure, or informational asymmetry. The reverse can also occur: centralized public ownership can support broad practical access. A concentration analysis should therefore trace the relevant form of command rather than infer control directly from nominal title.

Geographic and institutional concentration can interact. A capability may be legally open yet spatially concentrated in a few metropolitan regions. Knowledge may be publicly documented while interpretive expertise remains concentrated in specialized institutions. Data may be distributed across users while aggregation and model-training capacity are concentrated in a platform. Such cases show why concentration should be traced through the conversion interfaces identified in Section 14.6.

The distinction between accumulation and concentration can be stated formally without requiring a common scalar metric across value forms. Proposition 14.19 gives the scope principle.

Proposition 14.19 (Analytical separability of accumulation and concentration)**.** *Within a specified value form, population, historical interval, and representation, evidence of accumulation does not by itself establish increasing concentration, and evidence of concentration does not by itself establish aggregate accumulation. The two*

processes may interact, but their mechanisms and empirical indicators should remain distinguishable unless the research design establishes a justified relation between them.

Proposition 14.19 prevents a common inferential shortcut. A growing sector can become less concentrated; a stagnant sector can become more concentrated through redistribution; capability can accumulate across many positions while authority remains centralized; and institutional knowledge can expand while access becomes narrower. The proposition does not deny empirical relations between accumulation and concentration. It requires those relations to be demonstrated rather than assumed.

14.8.3 Relational Accumulation

Relational accumulation concerns the cumulative development of relations that become economically consequential in later processes. Repeated cooperation can build trust, familiarity, reputation, shared expectations, reciprocal obligation, communication channels, and knowledge of one another's capabilities. Network research and embeddedness traditions provide established precedents for treating economic action as structured by durable social relations rather than by isolated transactions alone (Granovetter 1985; Powell 1990). GRE extends this insight by asking how relational conditions themselves accumulate, convert into other value forms, and alter later generative opportunity.

The number of ties is an insufficient measure. A position can have many weak or redundant relations and limited practical access, while a smaller set of durable, trusted, or institutionally recognized relations can support substantial coordination capacity. Direction also matters: one actor can depend heavily on another without reciprocal dependence. Relational accumulation should therefore consider quality, durability, reciprocity, replaceability, brokerage, maintenance burden, and the capabilities that the relation makes possible.

Reputation illustrates cumulative relational value. A record of reliable participation can reduce the need for monitoring, widen access to partners, improve bargaining position, or make future collaboration easier. Such accumulation can be fragile because reputation depends on social recognition and can change after new evidence or institutional reclassification. Its value is therefore relationally realized rather than an intrinsic property stored inside the actor.

Relational accumulation can become concentrated. Brokerage positions, gatekeeping roles, platform control, elite networks, or exclusive professional communities can allow some actors to accumulate disproportionately valuable relations. The result can lower coordination costs for insiders while raising entry barriers for outsiders. A relational concentration analysis should distinguish productive specialization from exclusionary closure and identify whether alternative channels, contestation, or entry remain viable.

Maintenance is part of accumulation. Relations require time, attention, communication, care, legal support, shared infrastructure, or conflict resolution. An actor can appear relationally rich while the maintenance burden is distributed unevenly to less visible participants. GRE therefore treats accumulated relational value and the labor required to sustain it as distinct analytical objects.

Relational accumulation can also decay. Trust can erode, networks can fragment, organizational turnover can weaken tacit coordination, and technological change can make established ties less useful. Accumulation is therefore historical and revisable. Its analysis should include maintenance, depreciation, substitution, and transformation where those processes are material to the question.

14.8.4 Capability Accumulation

Capability accumulation concerns the cumulative development of substantive ability to perform, choose, participate, convert, maintain, or generate. Human-capital analysis provides one influential precedent for treating education and training as investments that affect later productivity and earnings (Becker 1964). Capability analysis widens the question toward what persons are substantively able to do and the social conditions that support or constrain those freedoms (Sen 1999). GRE draws on both lineages while preserving its own emphasis on relationally generated and historically inherited conversion capacity.

Capability can accumulate through learning by doing, formal education, mentorship, repeated problem solving, access to tools, health, infrastructure, organizational routines, language, and participation in demanding practices. These mechanisms often exhibit complementarity. A skill can become more useful when combined with another skill, a credential, a relation, institutional access, or technical infrastructure. Cumulative capability therefore cannot always be inferred from additive counts of courses, credentials, or years of experience.

Conversion conditions remain central. A person can possess knowledge without the legal authorization, equipment, time, institutional recognition, mobility, or social access needed to use it. Capability accumulation can thus be blocked at the interface between acquired potential and practical realization. Conversely, a modest resource transfer can generate substantial capability when complementary conditions are already present. The same nominal input can therefore yield different cumulative effects across positions.

Organizations accumulate capabilities as well. Production routines, quality-control practices, legal expertise, project-management competence, scientific methods, customer knowledge, and maintenance cultures can become embedded in teams and procedures. Organizational capability is not reducible to the sum of individual skills because coordination and institutional memory can matter. Turnover, restructuring, or outsourcing can therefore destroy capability even when many individual participants remain highly skilled.

Capability accumulation can reinforce inequality when prior capability lowers the cost of acquiring further capability or increases access to high-quality learning opportunities. It can also support broadening when public institutions, shared infrastructure, peer learning, or open knowledge reduce those barriers. Evaluation should therefore distinguish cumulative capability from the distribution of opportunities to acquire it.

Capability can also become obsolete or maladapted. Technical change can reduce the usefulness of accumulated expertise; rigid specialization can narrow later options; institutional change can invalidate credentials; and accumulated routines can

impede adaptation. Cumulative capability should therefore be assessed in relation to the changing environment and option space rather than treated as permanently additive.

14.8.5 Epistemic Accumulation

Epistemic accumulation concerns the cumulative development of knowledge, evidence, interpretive capacity, data, models, memory, credibility, and procedures for producing or evaluating claims. Economic activity is deeply dependent on such accumulation: firms learn about production and markets, scientific communities build bodies of evidence, public institutions retain administrative knowledge, and communities accumulate practical and ecological understanding. The cumulative object is not simply information stored somewhere; it includes the capacity to interpret, validate, connect, and use what has been retained.

Documentation is one mechanism. Records can preserve experience beyond individual memory, allowing later actors to learn from prior decisions. Standardization can make knowledge portable across sites. Research can add evidence or revise earlier beliefs. Repeated practice can produce tacit knowledge that is difficult to codify. Training can transfer accumulated understanding to new cohorts. Each mechanism preserves different dimensions and creates different risks of loss.

Epistemic accumulation is path-dependent because new knowledge is interpreted through existing concepts, standards, instruments, and institutional routines. Earlier classification systems can make some phenomena easier to observe while rendering others weakly visible. Accumulated models can reduce uncertainty while also stabilizing assumptions that later become difficult to revise. Epistemic accumulation therefore includes both expanded understanding and inherited representational commitments.

Credibility can accumulate alongside knowledge. A researcher, organization, profession, or institution with a record of successful work can gain greater attention and easier access to resources. This can improve efficiency when credibility tracks demonstrated competence, yet it can also concentrate epistemic authority when established positions receive disproportionate opportunities to generate the evidence that later confirms their standing. The distinction between accumulated knowledge and accumulated recognition should therefore remain visible.

Data-intensive settings make this issue especially clear. A large archive can improve prediction or research when data quality, coverage, governance, and interpretive capability are adequate. Scale alone does not establish epistemic value. Biased, poorly documented, or weakly governed data can accumulate error; proprietary control can concentrate epistemic capacity; and large technical systems can make validation expensive. Epistemic accumulation should therefore be evaluated through provenance, quality, access, interpretability, and the institutions governing revision.

Epistemic accumulation can be regenerative when accumulated knowledge improves the process through which further knowledge is generated. It can become extractive when one position repeatedly appropriates data or knowledge from others without meaningful return, recognition, participation, or access. The later section on extraction will develop that distinction more directly.

14.8.6 Institutional Accumulation

Institutional accumulation concerns the cumulative development of rules, procedures, recognized statuses, legal capacities, administrative routines, organizational memory, precedents, standards, and authority that shape later economic action. Institutional economics has long emphasized how durable rules and constraints structure incentives and interaction across time (North 1990). GRE adds attention to the value forms, conversion interfaces, and relational positions through which institutional accumulation becomes practically consequential.

Institutions accumulate by retaining prior decisions. A legal precedent can influence later interpretation. A standard can become embedded in contracts and technical systems. A bureaucracy can develop routines for evaluating applications. An organization can accumulate legitimacy, recognized jurisdiction, or procedural expertise. These inherited structures reduce the need to renegotiate every interaction and can make complex coordination possible.

Institutional accumulation can therefore create substantial value. Stable property or use rights can support investment; reliable procedures can reduce uncertainty; accumulated administrative capacity can improve public provision; recognized credentials can facilitate coordination across organizations. Yet institutional persistence is not itself evidence of value. A stable rule can preserve exclusion, inefficient procedure, discrimination, or dependence. The value of accumulated institutions must be evaluated in relation to their effects, contestability, historical conditions, and affected subjects.

Authority can accumulate alongside procedure. Repeated delegation, legal recognition, technical specialization, or control over standards can expand the discretion of particular organizations or offices. This can be functionally necessary while also concentrating decision power. Institutional accumulation should therefore distinguish accumulated competence, accumulated legitimacy, accumulated jurisdiction, and accumulated control.

Layering is another mechanism. New rules are often added to old ones rather than replacing them completely. The result can be a dense institutional architecture in which rights, exceptions, reporting duties, and jurisdictional boundaries reflect several historical periods. Layering can provide resilience and compromise, but it can also increase complexity and favor actors with specialized legal or administrative knowledge. Institutional accumulation therefore alters both substantive rules and the cost of navigating them.

Institutional memory can decay. Records disappear, staff turnover removes tacit knowledge, organizational reforms break continuity, and legal change can render earlier expertise less useful. Institutional accumulation is therefore maintained through documentation, training, succession, technical infrastructure, and repeated practice. These maintenance conditions should be included when accumulated institutional value is assessed.

14.8.7 Self-Reinforcing Advantage

Self-reinforcing advantage arises when an initial or inherited advantage changes subsequent conditions in ways that increase the likelihood, magnitude, or convertibility of later advantage. Economic and political research on increasing returns and path dependence provides well-established precedents for such mechanisms, including learning effects, coordination effects, adaptive expectations, complementary investment, switching costs, and institutional feedback (David 1985; Arthur 1989; Pierson 2000). GRE interprets these mechanisms through heterogeneous value forms rather than treating reinforcement as exclusively financial.

A capability advantage can improve access to advanced learning, which produces further capability. A strong reputation can attract better collaborators, generating knowledge and further recognition. Financial reserves can make it easier to survive shocks and invest during downturns. Institutional standing can provide earlier information or easier access to decision processes. Network centrality can increase the opportunities through which additional valuable relations are formed. These mechanisms can couple, creating a cumulative configuration whose later advantage cannot be explained by the initiating resource alone.

Self-reinforcement should be distinguished from deterministic lock-in. Feedback can be strong without making alternatives impossible. New technology, legal change, collective organization, public investment, migration, shocks, institutional reform, or deliberate redistribution can alter trajectories. Path dependence means that sequence and inherited configuration affect later possibilities; it does not mean that history mechanically fixes one outcome.

Thresholds can matter. An advantage may have little effect until complementary capabilities, scale, recognition, or network reach cross a practical threshold. After that point, conversion can become easier and returns can rise. Conversely, cumulative disadvantage can trap a position below thresholds needed for participation, credit, certification, technical adoption, or institutional recognition. The relevant threshold is mechanism-specific and should be empirically identified rather than inferred from metaphor.

Reinforcement can operate through expectations. When actors expect a technology, standard, institution, or organization to persist, they may invest in complementary assets that make persistence more likely. Credibility and coordination can therefore become self-confirming under some conditions. Similar mechanisms can support beneficial public standards or harmful monopolistic dependence; the normative status follows from the wider incidence and alternatives, not from feedback itself.

Protective or countervailing institutions can interrupt self-reinforcement. Public education, interoperability requirements, antitrust policy, open standards, social insurance, public research infrastructure, inheritance rules, mobility support, and contestable governance can alter the conversion mechanisms through which earlier advantage reproduces itself. Their effectiveness depends on the particular feedback architecture. A policy that changes financial distribution may leave relational or epistemic concentration untouched, while a change in access can matter more than a one-time transfer.

14.8.8 Intergenerational Accumulation

Intergenerational accumulation concerns value-bearing conditions, capabilities, relations, institutions, ecological states, rights, burdens, and option structures that persist or are transmitted across generational positions. Economics has long examined intergenerational resource and capital questions, including how exhaustible-resource use, investment, and reproducible capital affect later consumption possibilities (Solow 1974; Hartwick 1977). GRE retains these concerns while widening the inherited object beyond financial and reproducible capital.

Financial wealth is one pathway. Assets, housing, business ownership, savings, debt, and claims can be inherited directly or influence education, location, risk-bearing capacity, and access to credit before formal inheritance occurs. Material infrastructure is another pathway. Transport, energy systems, housing stock, public facilities, and environmental remediation shape the conversion conditions available to later cohorts.

Capabilities are also transmitted. Nutrition, health, education, language, professional knowledge, caregiving, expectations, and opportunities for practice can affect what later persons are substantively able to do. These processes are neither purely private nor fully deliberate. Families, schools, neighborhoods, labor markets, public institutions, and cultural environments jointly shape capability formation.

Relational and institutional inheritance can be equally consequential. Later generations can inherit professional networks, community trust, social recognition, organizational membership, citizenship status, legal rights, institutional credibility, or exclusion from such structures. They can also inherit administrative systems and public institutions built by earlier cohorts. Intergenerational accumulation therefore occurs through relational positions and collective structures as well as through transferable property.

Ecological conditions provide a particularly important non-financial inheritance. Soil, water, biodiversity, climate risk, pollution, and access to regenerative ecological systems can improve or constrain future generative capacity. Financial accumulation that depends on ecological depletion can therefore produce positive accumulation in one value form and negative inheritance in another. The plural-value architecture of this chapter is necessary precisely because one aggregate measure can hide such cross-form divergence.

Liabilities also accumulate intergenerationally. Public or private debt, deferred maintenance, contaminated land, obsolete infrastructure, institutional distrust, unresolved conflict, data dependence, and technical lock-in can impose future burdens. A generational analysis should therefore trace both inherited enabling conditions and inherited constraints. The relevant question is not simply what one cohort passes to another, but which future actions, conversions, and revisions the inherited configuration makes easier or harder.

Intergenerational accumulation also changes the standpoint of evaluation. Later actors can reinterpret the value of inherited institutions, technologies, monuments, resources, or obligations differently from earlier actors. Historical evaluation therefore requires both provenance and revisability. Inheritance does not freeze the meaning of what is inherited.

The analysis of Section 14.8 can be condensed into Proposition 14.20.

Proposition 14.20 (Cumulative provenance of value)**.** *Within a GRE value analysis, a claim about accumulation or concentration is adequately specified to the extent required by the research problem when it identifies the relevant value form or condition, the historical interval, the positions over which accumulation or concentration is assessed, the mechanisms carrying earlier conditions into later configurations, and materially relevant changes in access, control, convertibility, or burden. Cumulative increase alone does not establish concentration, self-reinforcement, justice, sustainability, or normative improvement.*

Proposition 14.20 preserves both explanatory reach and epistemic restraint. A financial-asset problem can often be studied with a narrow quantitative representation. A problem involving accumulated capability, knowledge, institutional authority, ecological burden, or inherited relational position requires a wider representation when those conditions change later possibility. The appropriate complexity follows the mechanism and the question.

The section also locates accumulation within the value-process sequence developed across Chapter 14. Generation creates or expands value-bearing conditions. Transmission and propagation move or extend them. Conversion changes the form or register through which they become effective. Recirculation returns conditions to later generative processes. Accumulation describes the historically cumulative configuration that can result when these processes persist across episodes; concentration describes how command or access becomes distributed within that configuration. Cumulative processes can support resilience, learning, capability, and institutional capacity, while they can also produce extraction, depletion, exclusion, and harm. The next section therefore examines dissipation, leakage, and extraction as distinct pathways through which value-bearing conditions can be lost, diverted, or appropriated.

14.9 Dissipation, Leakage, and Extraction

The value processes developed in Sections 14.4–14.8 describe generation, transmission, conversion, recirculation, accumulation, and concentration. The present section examines processes through which value-bearing conditions become less available, are diverted from a represented pathway, or are appropriated under asymmetrical relational conditions. Its role is to distinguish *dissipation*, *leakage*, and *extraction* before developing their relations to dependency, generative depletion, ecological depletion, epistemic extraction, and relational extraction. The objective is diagnostic rather than accusatory: the section specifies mechanism-level criteria that help determine what kind of loss, diversion, or appropriation has occurred, who bears it, who benefits, and how later generative capacity changes. The method is conceptual and process-oriented, with selective use of political-economic, ecological-economic, and generative-justice precedents where they clarify the mechanisms at issue.

These processes can coexist, but they should not be treated as synonyms. A productive input can dissipate through wear without being captured by another actor. Value can leak from an intended public programme toward an unintended recipient without the original process being intrinsically extractive. Extraction can occur

even when little of the appropriated value dissipates, because the central issue may concern asymmetric control over generation, realization, or return. Conversely, a system can suffer substantial generative depletion without a clearly identifiable extractor. The analytical task is therefore to preserve distinctions among *loss of usable organization*, *diversion from a pathway*, *appropriation under asymmetry*, and *later depletion of generative conditions*.

The distinction also protects the plural-value architecture of Chapter 14. A financial flow can grow while ecological capacity dissipates. Knowledge can spread while community control over that knowledge weakens. A firm can accumulate organizational capability while a supplier becomes increasingly dependent. A platform can generate convenient services while relational or epistemic burdens are shifted toward users. None of these cross-form patterns can be represented adequately by assuming that value is one conserved quantity whose movement can be read from a single balance sheet.

Definition 14.21 fixes the three principal process terms used throughout the section.

Definition 14.21 (Dissipation, leakage, and extraction)**.** Within a specified analytical boundary and value form, *dissipation* is a process through which a value-bearing condition loses practical availability, organization, convertibility, durability, or generative efficacy without requiring an identifiable beneficiary; *leakage* is a diversion, displacement, or unrepresented outflow through which value-bearing conditions or burdens move outside the pathway, recipient set, or incidence boundary specified by the analysis; and *extraction* is an asymmetrical process in which a position realizes, appropriates, or controls value generated with material contribution from another position or shared generative configuration while the source side experiences materially relevant loss of control, return, option, maintenance capacity, or future generative capacity.

Definition 14.21 is deliberately relational and scoped. Dissipation depends on what function or possibility is being assessed. Leakage depends on the boundary against which a flow is represented. Extraction depends on a specified asymmetry, provenance of contribution, appropriation mechanism, and source-side consequence. The three terms therefore require evidence appropriate to different claims. Evidence that output was lost does not by itself identify leakage; evidence of leakage does not establish extraction; evidence that one actor benefits while another loses does not establish extraction unless the relevant contribution, appropriation, asymmetry, and consequence can be reconstructed with sufficient warrant.

Table 14.9 summarizes the diagnostic distinctions developed below. The rows are compatible: one empirical process may instantiate several mechanisms simultaneously.

14.9.1 Dissipation

Dissipation concerns decline in the practical availability or organized efficacy of a value-bearing condition. The term is useful when an economically relevant condition becomes harder to use, convert, reproduce, or maintain even though no clear recipient receives what was lost. Physical wear provides an intuitive case: machinery

Table 14.9: Diagnostic architecture of dissipation, leakage, extraction, and depletion in GRE

Process	**Primary diagnostic question**	**Characteristic mechanism**	**Common analytical error**
Dissipation	What usable organization or generative efficacy declined?	Wear, decay, dispersion, entropy-like degradation, forgetting, maintenance failure, obsolescence	Inferring an extractor from any observed loss
Leakage	What moved outside the represented pathway or incidence boundary?	Diversion, spillover, displacement, side payment, boundary escape, burden shifting	Calling every spillover waste or extraction
Extraction	Who appropriated or controlled value under what asymmetry and with what source-side consequence?	Unequal control over generation, conversion, realization, return, or exit	Using "extraction" as a synonym for profit, transfer, or inequality
Dependency	Which position's later action becomes contingent on another position, interface, or infrastructure?	Switching cost, specialization, lock-in, exclusive access, asymmetric alternatives	Treating dependence itself as pathological
Generative depletion	Which conditions for later generation were reduced?	Capacity erosion, option foreclosure, maintenance deficit, institutional weakening, relational exhaustion	Measuring only immediate output loss
Ecological depletion	Which regenerative ecological conditions were reduced?	Stock drawdown, habitat degradation, pollution, residual accumulation, regeneration below use	Treating monetary compensation as automatic ecological replacement
Epistemic extraction	How were knowledge, data, attention, interpretation, or credibility appropriated and controlled?	Asymmetric capture of epistemic inputs, outputs, rights, or returns	Treating every use of shared knowledge or data as extractive
Relational extraction	How were trust, care, access, coordination, or relational maintenance appropriated without sustaining the relation?	Unequal use of relational capacity, maintenance burden, gatekeeping, exit constraint	Treating all relational benefit as extraction

loses functional capacity through use, infrastructure deteriorates when maintenance is deferred, and stored materials can degrade. Yet GRE uses the concept more broadly because capabilities, knowledge, relations, and institutions can also lose effective organization over time.

Capability can dissipate when skills are unused, health deteriorates, or complementary tools disappear. Epistemic value can dissipate when records are lost, tacit knowledge leaves with organizational turnover, or data remain stored but become uninterpretable because metadata, provenance, or technical context disappear. Relational value can dissipate when trust erodes, communication ceases, or repeated non-maintenance makes coordination increasingly costly. Institutional value can dissipate when formal rules remain in place but administrative competence, legitimacy, memory, or practical enforcement weakens. These processes differ materially, so dissipation should be specified by value form and mechanism rather than treated as one generic decay rate.

The idea should also be distinguished from physical entropy. In some material and energy problems, thermodynamic constraints provide an important background to non-perfect circularity and residual generation. Ecological-economic

material-balance analysis similarly emphasizes that production and consumption are embedded in physical throughput and residual flows (Ayres and Kneese 1969). GRE can use such insights where appropriate, but social or epistemic dissipation should not be redescribed as literal thermodynamic entropy merely because the metaphor is suggestive. A lost organizational routine and dispersed waste heat are different processes requiring different evidence.

Dissipation can be reversible, partially reversible, or effectively irreversible at the relevant horizon. A skill can sometimes be refreshed, a neglected infrastructure repaired, or an institution rebuilt. Other losses can exceed practical restoration capacity or require much greater resources than earlier maintenance would have required. The relevant evaluative question therefore concerns not only the magnitude of present loss but also the cost, feasibility, timing, and burden of restoration.

Maintenance is the practical counterpart of dissipation. Systems that appear to generate value continuously often depend on recurrent maintenance labor, replacement, repair, care, documentation, ecological regeneration, or institutional renewal. When maintenance is analytically invisible, observed output can be mistaken for self-sustaining generation. Dissipation analysis makes those hidden maintenance requirements visible without presuming that maintenance should preserve the existing arrangement indefinitely.

14.9.2 Leakage

Leakage is boundary-relative diversion. It occurs when value-bearing conditions, benefits, burdens, or effects move outside the pathway or incidence set represented by an allocation, institution, contract, programme, model, or evaluative frame. The concept therefore requires an explicit boundary. A transfer programme can experience financial leakage if resources reach ineligible recipients; an environmental intervention can experience burden leakage if pollution is displaced across jurisdictions; an organization can experience knowledge leakage when proprietary knowledge moves outside authorized channels; a public investment can produce positive spillovers that appear as “leakage” only from the narrow accounting perspective of the funding institution.

This last case is important. Leakage is not inherently negative. A benefit that escapes a private boundary can become a social spillover. Knowledge produced in one project can diffuse productively to another. A local infrastructure investment can generate regional gains. Conversely, costs can leak outward through pollution, unpaid care burdens, congestion, risk transfer, or financial liabilities. The normative status of leakage therefore depends on what moves, where it moves, who gains or bears burdens, and which boundary is normatively relevant.

Leakage can reveal a mismatch between accounting boundary and causal boundary. A firm-level balance sheet may record a profitable process while ecological or social burdens occur outside the firm. A project can meet its internal performance target while displacing costs onto another agency or later period. A national policy can improve a domestic indicator while shifting resource-intensive production abroad. These cases do not imply that organizational or jurisdictional boundaries are analytically useless. They show that incidence analysis may need a wider boundary when

omitted flows materially affect the question.

Leakage can also be endogenous to institutional design. Complex eligibility rules, fragmented responsibility, weak monitoring, incentives for boundary shifting, or incompatible accounting systems can create channels through which resources or burdens move away from the stated purpose. In such cases the appropriate diagnosis concerns the design and governance of the pathway, rather than moral characterization of every actor within it.

A leakage claim should therefore identify at least four elements: the represented pathway or boundary, the value-bearing condition or burden that leaves it, the mechanism of diversion, and the receiving or affected position where this is observable. When the recipient cannot be identified, the process may be closer to dissipation. When the diversion is controlled asymmetrically and depletes the source's generative conditions, extraction may become the more informative category.

14.9.3 Extraction

Extraction is the most relationally and normatively demanding category in the section. Political economy has long examined processes in which value generated through labor, production, exchange, land, or institutional arrangements is appropriated asymmetrically. Marx's analysis of surplus value provides one historically influential account of appropriation within capitalist production (Marx 1867). More recent generative-justice work places particular emphasis on protecting value generators from extraction and on returning value to the human and non-human communities involved in generation (Eglash 2016; Eglash et al. 2024). GRE draws on these lineages while using extraction as a mechanism-specific term rather than as an automatic label for profit, inequality, market exchange, or intermediation.

Within GRE, an extraction claim becomes analytically stronger when several elements can be reconstructed together: a source position or generative configuration contributes materially to the production or realization of value; another position gains disproportionate control over appropriation, conversion, realization, or return; the asymmetry limits the source side's effective bargaining, contestation, exit, recognition, or access to alternatives; and the process reduces source-side control, return, maintenance conditions, option space, or later generative capacity in a materially relevant way. The combination matters because isolated evidence of benefit or asymmetry is insufficient.

Extraction can operate through several value forms. Financial extraction can involve appropriation of monetary returns through contractual or structural power. Capability extraction can occur when a process intensively uses skills while failing to maintain the health, learning, or autonomy on which those skills depend. Epistemic extraction can appropriate knowledge, data, attention, interpretation, or credibility while restricting contributor control over use or return. Relational extraction can depend on trust, care, community access, reputation, or coordination labor without sustaining the relations that make those benefits possible. Ecological extraction can transform environmental conditions into realized economic value while degrading the regenerative systems on which future activity depends.

Intermediation should not be equated with extraction. Intermediaries can pro-

vide genuine coordination, risk bearing, verification, translation, logistics, finance, technical infrastructure, or governance. Global value-chain research, for example, documents heterogeneous governance arrangements in which coordination requirements and capability differences shape power relations among firms (Gereffi et al. 2005). The GRE question is therefore not whether one position receives more than another in nominal terms, but what functions each position performs, how returns and burdens are allocated, what alternatives exist, and whether the arrangement depletes or constrains the generative conditions of contributing positions.

Extraction can also coexist with consent. A formally voluntary agreement can occur under highly asymmetric alternatives, information, dependency, or institutional standing. Conversely, asymmetric exchange is not necessarily extractive when the source side retains meaningful alternatives, receives returns adequate to sustain participation under the relevant evaluative framework, and preserves control over future generative conditions. The concept therefore requires relational analysis beyond the legal form of consent alone.

14.9.4 Dependency

Dependency concerns a condition in which one position's continued ability to act, convert, participate, maintain, or generate becomes materially contingent on another position, interface, infrastructure, institution, or relation. Section 14.8 examined how cumulative advantage and institutional or relational accumulation can create asymmetric positions. Dependency identifies one possible relational consequence of those histories.

Dependence is common in complex economic life. Workers depend on organizations, firms on suppliers and infrastructures, households on public services, researchers on institutions and data, platforms on users, users on platforms, and communities on ecological systems. Mutual dependence can support specialization, coordination, trust, and large-scale collective capacity. The relevant problem therefore concerns the architecture of dependency rather than dependence as such.

Several features affect that architecture. Replaceability concerns whether alternative partners, infrastructures, or standards are practically available. Switching cost concerns the burden of moving to an alternative. Directionality concerns whether dependence is reciprocal or one-sided. Control concerns who can change terms or interrupt access. Time concerns whether dependency is temporary, adaptive, or cumulative. Exit concerns whether nominal alternatives can actually be used. A dependency can be deep even when the direct financial transfer between positions is small.

Extraction and dependency can reinforce one another. A dependent position may have weaker ability to contest appropriation or demand return. Repeated extraction can in turn deepen dependency by reducing savings, capabilities, institutional standing, relational alternatives, or technical interoperability. Yet the relation is not necessary in either direction. Dependency can be protective or productive; extraction can occur opportunistically without producing long-term dependency. Empirical analysis should therefore identify the feedback mechanism rather than infer one process from the other.

Dependency also interacts with conversion interfaces. Control over a credential, payment system, platform, language standard, legal status, distribution channel, or computational infrastructure can determine whether other value forms become practically realizable. A position may possess material or epistemic value while remaining dependent on an institution that controls its conversion into recognized rights, income, participation, or credibility. Such cases link dependency analysis to the conversion architecture developed in Section 14.6.

14.9.5 Generative Depletion

Generative depletion is a decline in the conditions through which later value, capacity, relation, knowledge, institution, participation, ecological function, or option can be generated or regenerated. It shifts attention from what is lost immediately to what becomes harder to produce later. This temporal distinction is central to GRE because an arrangement can preserve current output while consuming the conditions of future generation.

Generative depletion can occur through under-maintenance. An organization can maintain production by postponing training, equipment replacement, documentation, or institutional renewal. A household can meet present obligations by exhausting savings, health, or time needed for later capability formation. A research system can maximize short-term publication output while eroding mentorship, replication, methodological diversity, or long-horizon inquiry. A community can sustain current income while losing ecological or relational conditions required for future autonomy. In each case current performance can mask deterioration in generative capacity.

The concept is broader than depreciation. Depreciation usually concerns decline in the value or productive capacity of an asset. Generative depletion can involve the erosion of relations among several conditions: trust, compatible standards, institutional memory, ecological regeneration, skill complementarity, access, and option diversity. A stock measure can therefore miss depletion occurring in the architecture that allows several stocks to work together.

Generative depletion can be distributed unevenly. One actor can realize current benefits while another bears the future loss. A firm can externalize training costs onto workers or suppliers; a platform can preserve innovation capacity while contributors lose control over data or visibility; one jurisdiction can realize revenue while another bears ecological degradation. Such cases link depletion to leakage or extraction when the relevant mechanism is present.

The analysis also requires a baseline. Some activities intentionally transform old generative conditions to create new ones. Closing an obsolete institution, replacing a technology, or ending a harmful relation can reduce one kind of future generation while enabling another. A depletion claim should therefore specify what later capability or option is reduced, over what horizon, relative to which plausible alternative, and for which affected positions. The term should not function as a general objection to structural change.

Definition 14.22 states the concept used in the remainder of the section.

Definition 14.22 (Generative depletion)**.** *Generative depletion* is a historically situ-

ated reduction in the practical capacity of a specified subject, collective, institution, relation, ecological system, or other generative configuration to maintain, regenerate, or develop economically relevant value-bearing conditions or future options. The claim should identify the affected generative condition, the mechanism of reduction, the relevant horizon, and the positions over which the depletion is assessed.

14.9.6 Ecological Depletion

Ecological depletion concerns reduction in ecological stocks, regenerative functions, assimilative capacities, biodiversity, habitat integrity, soil fertility, water quality, climate stability, or other environmental conditions on which present and future economic activity depends. Ecological economics provides established precedents for treating economic systems as embedded in material throughput and ecological systems rather than as self-contained monetary circuits (Costanza 1989; Ayres and Kneese 1969). Sustainability approaches similarly emphasize relations between resource use, regeneration, waste, and assimilative capacity (Daly 1990; Costanza and Daly 1992).

GRE uses this literature to clarify a value-process question: ecological value can be generated, maintained, depleted, transmitted across generations, converted into other forms, or made inaccessible through institutional change. Monetary income obtained through resource use can therefore coexist with ecological depletion. The two observations are compatible because they concern different value forms and different positions in a historical trajectory.

Ecological depletion should not be reduced automatically to a monetary equivalent. Monetary valuation can be useful for some policy questions, but it is one conversion interface among others. Ecosystem functions can have threshold behavior, irreversibility, uncertainty, cultural significance, distributional incidence, and dependence relations that a single price may not represent adequately. Research on social-ecological systems further emphasizes the coupled roles of resource systems, governance, users, interactions, and outcomes (Ostrom 2009). A GRE ecological-depletion analysis should therefore retain the ecological mechanism and governance configuration alongside any monetary representation.

Regeneration rate matters. Use of a renewable resource need not be depleting when regeneration and governance maintain the relevant stock or function within the specified horizon. Conversely, apparent stock stability can conceal declining quality, resilience, or diversity. For non-renewable resources, the relevant question shifts toward depletion trajectory, substitutability, generated alternatives, burden distribution, and the inheritance left to later positions. No universal sustainability rule follows from the value-form taxonomy alone.

Ecological depletion can also be displaced spatially or temporally. Production can move ecological burdens across jurisdictions, supply chains, or generations. A domestic environmental improvement can therefore coexist with imported ecological pressure. Such cases combine depletion with leakage when the analytical boundary excludes affected locations or later periods. They can become extractive when asymmetrical appropriation and source-side generative depletion are additionally established.

14.9.7 Epistemic Extraction

Epistemic extraction concerns asymmetrical appropriation of knowledge, data, attention, interpretation, experience, credibility, or other epistemic contributions under conditions in which contributors lose materially relevant control, return, recognition, access, or future epistemic capacity. The concept builds on the broader extraction criteria established in Subsection 14.9.3; it does not treat learning from others, citation, data use, or knowledge diffusion as inherently extractive.

Information has economic properties that differ from many ordinary commodities, including uncertainty about its value before acquisition and difficulties of exclusive appropriation once disclosed (Arrow 1962). These properties can support socially productive diffusion, but they also complicate provenance and return. Knowledge can be copied without physically removing the original, while control over recognition, licensing, aggregation, model training, publication, credentialing, or downstream commercialization becomes concentrated elsewhere. The absence of physical subtraction therefore does not settle whether an extractive relation exists.

Several mechanisms can matter. Contributors can supply data or situated knowledge without meaningful visibility into later use. Workers can produce process knowledge that becomes embedded in organizational systems while losing bargaining leverage or access to the resulting tools. Communities can provide cultural, ecological, linguistic, or local knowledge that is translated into commercial or administrative forms controlled by outside institutions. Users can generate behavioral traces whose aggregate value depends on scale, while individual rights over downstream use remain weak. Researchers can depend on unpaid reviewing, curation, replication, or maintenance labor that is essential to epistemic production but poorly represented in reward systems.

Epistemic extraction should be diagnosed cautiously. Open science, shared standards, collaborative learning, and public knowledge infrastructures intentionally permit broad reuse. Their value can increase through diffusion. The relevant distinction concerns governance of contribution and return: whether participation is informed where appropriate, whether provenance is preserved, whether contributors retain meaningful rights or recognition, whether benefits and burdens are distributed defensibly, whether alternative access exists, and whether the process erodes the contributor's later epistemic or institutional capacity.

Generative-justice analysis is particularly relevant where epistemic contributions are converted into value elsewhere while the originating community or contributors lose control over the conditions of future generation (Eglash 2016; Eglash et al. 2024). GRE adds the typed transmission and conversion architecture developed earlier in this chapter: epistemic extraction can involve an epistemic input converted into financial, institutional, capability, or reputational value, with the conversion interface controlled asymmetrically. The analysis should therefore trace both the source epistemic form and the downstream form in which appropriation becomes effective.

14.9.8 Relational Extraction

Relational extraction concerns asymmetrical use or appropriation of trust, care, access, reputation, social coordination, community legitimacy, brokerage, emotional labor, or other value-bearing relational conditions in ways that fail to sustain the relations on which realization depends and materially reduce the source side's control, reciprocity, exit, or future relational capacity. Because economic action is embedded in ongoing social relations, relational conditions can affect access, monitoring costs, cooperation, and institutional operation (Granovetter 1985). GRE extends this observation toward the maintenance and depletion of the relations themselves.

The concept is needed because relational resources can be consumed without appearing as conventional inputs. A trusted community intermediary can repeatedly provide introductions, interpretation, conflict resolution, or legitimacy to an outside organization. A caregiver can maintain the emotional and practical conditions that allow another person to participate in paid work. Users can supply network participation that makes a platform valuable. Long-standing suppliers can absorb adaptation burdens to preserve a buyer relationship. In each case the realized benefit partly depends on relational capacity whose maintenance may be unevenly recognized or rewarded.

Relational extraction should not be inferred from asymmetry alone. Many relations involve differentiated roles, gifts, obligations, voluntary care, or unequal but mutually valued contributions. The stronger extraction claim requires evidence that one side systematically realizes value from the relation while externalizing maintenance burdens, constraining meaningful exit, appropriating relationally generated returns, or eroding the source side's ability to reproduce the relation or build alternatives.

Maintenance is again central. Trust can reduce formal contracting costs, but repeated exploitation of trust can destroy it. Community legitimacy can lower entry barriers for an institution, but bypassing the community in later decisions can weaken the legitimacy that enabled the project. Care can sustain capability, but chronic under-recognition can deplete the caregiver's health, time, or options. Relational extraction therefore often appears dynamically as current realization coupled with future relational depletion.

Relational extraction can also operate through gatekeeping. Actors controlling access to professional networks, platforms, supply chains, or institutions can demand disproportionate concessions because alternatives are weak. Here the extracted object may not be a transferable "thing" but a change in bargaining position, visibility, recognition, or access. The value is realized through the relation, and the burden is likewise relational.

The distinctions developed across Section 14.9 can be summarized by Proposition 14.23.

Proposition 14.23 (Process-specific diagnosis of loss and appropriation)**.** *Within a GRE value analysis, an adequate claim about dissipation, leakage, extraction, dependency, or generative depletion should identify, to the level required by the research problem, the relevant value form or generative condition, the analytical boundary, the mechanism of loss, diversion, appropriation, or contingency, the materially affected po-*

sitions, the historical horizon, and any identifiable beneficiary or controlling position. Evidence for one process does not by itself establish another, and a finding of value loss or asymmetry does not by itself establish extraction or normative harm.

Proposition 14.23 preserves two kinds of restraint. The first is causal: loss, diversion, appropriation, dependency, and depletion require different evidence. The second is normative: dissipation can be ordinary depreciation, leakage can be beneficial diffusion, dependency can be productive, and extraction can be contested in both its empirical diagnosis and evaluative significance. Stronger conclusions require the relevant mechanism and standpoint to be stated.

The proposition also clarifies the transition within Chapter 14. The present section has identified ways in which value-bearing conditions can be lost, diverted, appropriated, or depleted. These processes can produce harm, but they are not identical to harm. The next section therefore turns to negative value and harm directly, examining capacity loss, relational erosion, constraint generation, option foreclosure, institutional damage, long-horizon harm, and irreversibility as evaluative and historical consequences rather than treating them as automatic synonyms for dissipation or extraction.

14.10 Negative Value and Harm

The preceding section distinguished dissipation, leakage, extraction, dependency, and generative depletion as process-level diagnoses. The present section turns from those mechanisms to the evaluative question of *negative value and harm*. Its role is to identify several ways in which economic processes can adversely affect capabilities, relations, constraints, options, institutions, and long-horizon generative conditions while preserving the distinction between causal diagnosis and normative evaluation. The objective is to provide a layered vocabulary for harm that remains compatible with Chapter 14's plural-value architecture. The method is conceptual and historically situated: harm claims are indexed to affected positions, value forms, evaluative standpoints, temporal horizons, and evidentially supported mechanisms rather than inferred automatically from observed loss or asymmetry.

This distinction matters because processes diagnosed in Section 14.9 can have different evaluative meanings. Dissipation can be ordinary depreciation, planned consumption, or harmful capacity loss. Leakage can describe beneficial diffusion, tolerated spillover, or harmful diversion. Dependency can support specialization, care, or collective coordination, while some dependency structures expose one position to severe vulnerability. Extraction can support a strong harm claim when appropriation erodes another position's control or generative capacity, yet the empirical diagnosis of extraction and the normative evaluation of its consequences remain analytically distinct steps. GRE therefore treats mechanism, incidence, and evaluation as related but non-identical layers.

The same restraint applies to the idea of *negative value*. Chapter 14 has treated value as plural, situated, and relationally manifest. Negative value should accordingly not be understood as a universal quantity obtained by placing a minus sign before a positive scalar. A polluted water source, a coercive institutional rule, a de-

grading relation, a lost capability, and a foreclosed option can each carry negative economic significance, but the relevant dimensions, affected positions, evidence, and possibilities of restoration differ. Where comparison is required, the conversion or aggregation procedure must be stated rather than presumed.

Definition 14.24 establishes the working distinction used throughout the section.

Definition 14.24 (Negative value and harm)**.** Within a specified evaluative framework, *negative value* is an adverse significance attributed to a condition, process, relation, burden, risk, or consequence. *Harm* is a materially adverse change borne by an affected subject, collective, institution, ecological system, or other explicitly represented position through loss, degradation, constraint, foreclosure, damage, or reduction of practically relevant generative conditions. A harm claim should identify the affected position, the relevant value form or capability, the evaluative standpoint, the historical horizon, and the evidential basis for attributing the adverse change to the process under analysis.

Definition 14.24 separates three questions. The first asks whether a condition is evaluated negatively. The second asks whether an affected position underwent a materially adverse change. The third asks how strongly that change can be attributed to a specified process. A negative valuation can exist without a completed harm event, as with an anticipated risk or an objectionable institutional rule whose effects have not yet materialized. Harm can also occur without a simple transfer of value to a beneficiary, as in ecological degradation, loss of health, organizational forgetting, or option foreclosure. Strong causal attribution requires additional evidence beyond the evaluative judgment itself.

Table 14.10 summarizes the analytical dimensions developed below. The rows are intentionally non-exclusive. A single process can reduce capability, erode relations, generate constraints, foreclose options, damage institutions, and create long-horizon effects simultaneously.

14.10.1 Harm

Harm is the broadest evaluative category in this section, but analytical breadth should not become conceptual looseness. A GRE harm analysis begins by identifying who or what bears an adverse change, what condition has changed, according to which evaluative standpoint the change is adverse, and over what temporal and relational boundary the claim is made. This procedure allows harm to remain plural without turning every disliked outcome into a theoretically equivalent event.

The affected position can be a person, household, organization, community, institution, ecosystem, or another unit justified by the research problem. Different positions can evaluate the same process differently. A new infrastructure project can improve mobility for some households while disrupting ecological functions or community relations elsewhere. A digital platform can lower transaction costs for users while increasing dependency for suppliers. A restructuring can preserve organizational survival while reducing worker capability or local institutional continuity. A harm analysis should therefore preserve incidence rather than seeking an immediate net judgment.

Table 14.10: Analytical architecture of negative value and harm in GRE

Dimension	**Primary analytical object**	**Characteristic adverse change**	**Principal caution**
Harm	Affected position under an explicit evaluative frame	Materially adverse change in conditions, relations, capacities, burdens, or future possibilities	Do not infer harm solely from mechanism labels such as dependence or dissipation
Capacity loss	Effective ability to act, participate, convert resources, or sustain functioning	Erosion of skills, health, access, complementary conditions, or practical agency	Resource loss and capability loss need not coincide
Relational erosion	Trust, reciprocity, coordination, care, legitimacy, or reliable connection	Rising maintenance burden, fragility, distrust, exclusion, or loss of relational capacity	Relationship change is not automatically harmful to every party
Constraint generation	Feasible action and conversion conditions	New obligations, switching costs, gatekeeping, exposure, prohibitions, or dependence	Constraints can also enable coordination and protection
Option foreclosure	Reachable future actions, relations, or trajectories	Removal, practical inaccessibility, or severe narrowing of later possibilities	Non-selection of an option is not by itself foreclosure
Institutional damage	Rules, capacities, legitimacy, memory, enforcement, and procedural access	Degradation of institutional function, credibility, contestability, or continuity	Institutional change and institutional damage are not equivalent
Long-horizon harm	Delayed and inherited incidence	Adverse effects appearing through accumulation, latency, reproduction, or intergenerational transmission	Later observation should not erase information available at the earlier decision point
Irreversibility	Restoration, exit, and alternative-history feasibility	Loss whose restoration is impossible, prohibitively costly, or unavailable within the relevant horizon	Irreversibility is horizon- and mechanism-specific unless stronger proof exists

Harm can concern an achieved state, a process, or an altered trajectory. An achieved-state harm might be injury, lost income, degraded water quality, or exclusion from an institution. A process harm can involve coercive monitoring, chronic maintenance burden, or repeated exposure to uncertainty even when final outcomes remain uncertain. A trajectory harm occurs when present change worsens later capacities, options, or generative conditions. These distinctions matter because a static endpoint comparison can miss burdens experienced during the process or future possibilities that have been removed.

The capability tradition provides one important precedent for distinguishing resources from substantive opportunities. Sen's emphasis on substantive freedoms and effective opportunities makes it possible to identify deprivation even when nominal resources appear similar (Sen 1999). GRE retains that distinction while widening the analytical object to include relations, institutional conditions, ecological supports, and later generative possibilities. The extension should not be read as replacing capability analysis; it specifies additional mechanisms through which economically relevant harm can occur.

Harm attribution also requires causal restraint. An adverse condition observed after an intervention can have several causes, including background trends, interacting institutions, independent shocks, or earlier path dependence. The language of harm can remain normatively clear while causal language remains probabilistic or contributory. Where evidence supports only contribution, mediation, or increased exposure, the manuscript should state that level rather than silently upgrading it to

exclusive causation.

A final distinction concerns accepted burdens. Some activities deliberately incur short-term cost, effort, discomfort, or risk in pursuit of later benefit. Training can be demanding, taxation can reduce disposable income while financing public capacity, and ecological restoration can restrict present extraction. A burden is not therefore harmless merely because it is purposeful, nor harmful merely because it is costly. The relevant assessment concerns justification, distribution, consent where applicable, alternatives, proportionality, and effects on later capability and agency.

14.10.2 Capacity Loss

Capacity loss occurs when a position's effective ability to perform, participate, convert resources, maintain itself, or pursue practically relevant functions declines. The analytical emphasis is on effective ability rather than on possession alone. A person can retain nominal income while losing health, mobility, time, legal status, or access to complementary infrastructure. An organization can retain physical assets while losing skilled personnel, routines, interpretive competence, or supplier relationships. A community can retain formal rights while losing the practical capacity to exercise them.

The distinction between resource loss and capacity loss is therefore central. A resource transfer can occur without significant capability change if substitutes are available. Conversely, capability can decline even without direct subtraction of owned resources. Increased administrative complexity can make an entitlement harder to use. A change in technical standards can make existing equipment obsolete. Loss of a caregiver, translator, professional network, or institutional sponsor can sharply reduce practical possibilities while leaving the formal resource bundle unchanged.

Capacity loss can be direct or mediated. Direct loss includes deterioration of health, destruction of equipment, or removal of legal authorization. Mediated loss arises when conversion conditions change. For example, a training credential can lose practical significance if licensing rules change; financial resources can become less useful when mobility is restricted; information can fail to support action when interpretive capacity is absent. GRE therefore evaluates capacity in relation to the surrounding relational and institutional configuration rather than as a property stored wholly inside an isolated subject.

Maintenance matters as much as acquisition. Capabilities can decay through nonuse, overload, underinvestment, institutional neglect, or depletion of complementary conditions. A policy that creates a capability initially but does not sustain the infrastructure, staffing, knowledge, or relational support required for continued use may produce a temporary gain followed by later loss. This temporal pattern can be missed if evaluation ends at the moment of provision.

Capacity loss can also be unevenly distributed within collectives. Organizational adaptation may increase aggregate productive capacity while concentrating decision authority or reducing some members' skills through deskilling. Technological change may increase total system capability while making participation dependent on infrastructures controlled by a narrower set of actors. A GRE analysis should therefore ask

which capacities grow, which decline, for whom, under what conversion conditions, and with what consequences for later participation and exit.

14.10.3 Relational Erosion

Relational erosion concerns degradation of economically consequential relations or of the conditions that sustain them. Trust, reciprocity, communication, legitimacy, care, brokerage, repeated coordination, and mutual recognition can all support economic activity. Economic action is often embedded in ongoing social relations rather than reducible to atomized exchange (Granovetter 1985). When those relational conditions weaken, costs and vulnerabilities can change even if material stocks remain similar.

Erosion should be distinguished from ordinary relational change. Some relations should end. Exit from an abusive, exploitative, or obsolete relation can increase capability and future opportunity. Reorganization can replace one network with another. Institutional reform can deliberately dissolve patronage ties. The relevant question is therefore whether the change degrades a relational condition that is materially important to the affected position under the stated evaluative framework, not whether a relation simply becomes less persistent.

Several mechanisms can produce relational erosion. Repeated opportunism can weaken trust. Chronic under-recognition of maintenance labor can exhaust care or coordination capacity. Centralization can bypass local intermediaries whose legitimacy previously supported implementation. High turnover can disrupt organizational memory and informal cooperation. Competitive incentives can reduce information sharing. Surveillance can increase compliance while weakening trust or willingness to communicate candidly. These effects are relational because they alter expectations and patterns of interaction through which later action becomes possible.

Relational erosion can be asymmetric. One party can retain access to a network while another loses standing within it. A platform can preserve user participation while individual suppliers become more replaceable. An organization can continue benefiting from community legitimacy while reducing the community's influence over decisions. The analysis should therefore trace maintenance burdens, replaceability, exit, reciprocity, and control over relational interfaces rather than measuring relationship density alone.

Relational harm also has temporal depth. Trust can take years to establish and be damaged rapidly. Once coordination routines disappear, restoration can require repeated evidence of reliability rather than a single compensating payment. The cost of repair can therefore be nonlinear and historically dependent. Relational erosion becomes particularly consequential when it combines with option foreclosure: damaged relations can remove access to information, credit, collaboration, care, political voice, or institutional sponsorship that would otherwise support alternative trajectories.

14.10.4 Constraint Generation

Economic processes generate constraints as well as resources and opportunities. A constraint is a condition that narrows, conditions, delays, raises the cost of, or otherwise structures a set of feasible actions or conversions. Constraints can be legal, institutional, technical, financial, spatial, temporal, relational, informational, ecological, or embodied. Their generation becomes a harm problem when the resulting restriction is materially adverse under the relevant evaluative standpoint and incidence pattern.

The category should not be treated as intrinsically negative. Institutions are partly constituted by rules and constraints that can reduce uncertainty, enable cooperation, protect rights, maintain safety, or preserve common resources. North's institutional analysis, for example, emphasizes institutions as humanly devised constraints that structure interaction and incentives (North 1990). The evaluative question is therefore not whether constraint exists, but which constraint is generated, whom it binds, what it enables or disables, how it can be contested, and how its burdens and protections are distributed.

Constraint generation can occur unintentionally. A technical standard adopted for interoperability can create switching costs. A funding rule designed for accountability can exclude small organizations lacking administrative capacity. Security procedures can limit mobility or participation. Long-term contracts can support investment while reducing future exit. Debt can finance capability formation while creating repayment obligations that narrow later choices. Infrastructure can open one route while making alternative infrastructures less viable through network effects or complementary investment.

Constraints can also be generated recursively. An initial restriction changes behavior; the changed behavior alters investment, relationships, and institutions; those changes make the original restriction harder to escape. The process can therefore move from a local rule to a broader path-dependent configuration. Increasing-return mechanisms provide one established way in which early arrangements can become progressively more difficult to displace under specified conditions (Arthur 1989; Pierson 2000). GRE uses this insight only where a corresponding self-reinforcing mechanism can be identified.

A useful diagnostic distinction is between *protective*, *coordinating*, and *restrictive* incidence. A regulation can protect one group from harm, coordinate expectations among many actors, and restrict another group's action simultaneously. These effects can coexist. The analysis should therefore avoid classifying a rule globally as "constraint" in a purely negative sense; it should trace the specific action-space changes and affected positions.

14.10.5 Option Foreclosure

Option foreclosure is a stronger claim than non-selection. An option is foreclosed when a previously reachable or plausibly preservable future action, relation, institutional arrangement, or trajectory becomes unavailable or practically inaccessible because of a specified process. A decision that simply chooses one option today does

not necessarily foreclose the others; they may remain available later. Foreclosure concerns a change in the structure of future possibility.

The distinction between nominal and effective options is essential. A legal right can remain formally available while costs, eligibility conditions, knowledge requirements, geography, dependency, or relational access make its use practically impossible. Conversely, an option can disappear formally while functionally equivalent alternatives remain accessible. The relevant unit is therefore practical reachability under the stated model of action, not the number of alternatives listed in an administrative document.

Foreclosure can arise through several mechanisms. Specialized investment can make switching prohibitively costly. Ecological degradation can eliminate future uses of a resource. Loss of institutional standing can close professional or legal pathways. A platform standard can make alternative infrastructures incompatible. Debt or contractual obligations can constrain future allocation. Destruction of archival or tacit knowledge can make a technical process impossible to reproduce. Relational erosion can remove trusted intermediaries required for access. These examples differ in value form but share a change in later feasible trajectories.

Option foreclosure can also be collective. A community can lose the capacity to govern a resource locally. A profession can become dependent on a proprietary infrastructure. A state can lose policy space through long-lived commitments. An ecosystem can cross a threshold after which previous configurations cannot be restored within relevant horizons. Collective foreclosure matters because individuals may retain nominal alternatives while the institutional or ecological conditions needed for those alternatives disappear at a higher scale.

Foreclosure is evaluatively complex. Eliminating some options can be desirable when the options are harmful, coercive, or incompatible with protecting others. Safety regulation deliberately forecloses certain production methods; conservation rules can restrict extraction to preserve later ecological options. The harm claim therefore requires an evaluative account of which option was lost, for whom, with what justification, and what alternatives or protections remain. GRE's concern is with the generated structure of possibility, not with a presumption that more options are always better.

14.10.6 Institutional Damage

Institutional damage concerns degradation of the capacities, rules, legitimacy, memory, enforcement, procedural access, or contestability through which an institution performs economically relevant functions. Institutions can structure incentives, reduce uncertainty, allocate authority, establish rights, coordinate expectations, and stabilize repeated interaction (North 1990). Damage occurs when materially important aspects of those functions deteriorate under the evaluative frame adopted by the analysis.

Institutional damage should be distinguished from institutional change. Institutions sometimes require reform, replacement, or dissolution. A declining institution may be losing an unjust privilege rather than suffering a harm that should be repaired. The analysis therefore needs a functional and normative specification: which

institutional capacity is deteriorating, whose interests or rights it serves, what alternative institutions exist, and whether the lost function should be preserved, transformed, or abandoned.

Several forms of damage are analytically distinct. *Capacity damage* reduces staffing, expertise, fiscal resources, data, infrastructure, or implementation ability. *Procedural damage* weakens due process, transparency, participation, review, or contestation. *Legitimacy damage* reduces willingness to comply, cooperate, or treat institutional decisions as authoritative. *Memory damage* erodes records, routines, precedent, or tacit knowledge. *Access damage* makes institutions harder to reach or use for some groups. *Coordination damage* weakens the institution's ability to align actors across time or scale.

These forms can interact. Reduced capacity can produce delays, which weaken trust, which reduce compliance, which further increases administrative burden. Political or financial shocks can accelerate the cycle. Conversely, institutional resilience can interrupt it through redundancy, professional norms, external support, learning, or legitimate reform. Harm analysis should therefore identify mechanisms rather than treating institutional deterioration as an undifferentiated decline.

Institutional damage often redistributes private burdens before aggregate indicators reveal failure. When a public service becomes less reliable, households may compensate with unpaid care, private expenditure, additional travel, or informal networks. When regulatory capability declines, firms may face greater uncertainty and communities greater exposure. When courts or administrative review become inaccessible, formally retained rights can lose practical value. Institutional harm is therefore often partly visible through the conversion burdens transferred to other positions.

14.10.7 Long-Horizon Harm

Long-horizon harm appears, accumulates, or becomes fully intelligible only across extended temporal sequences. The category includes delayed effects, cumulative burdens, intergenerational incidence, path-dependent constraints, slow ecological degradation, institutional erosion, and losses whose significance emerges only after complementary conditions change. It extends the temporal analysis developed in Chapter 13 by focusing specifically on adverse value incidence rather than on allocation timing itself.

A long horizon changes both evidence and responsibility. At the time of action, some later effects may be foreseeable, probabilistic, poorly understood, or outside the dominant evaluative frame. Later observers can know more. Historical evaluation should therefore distinguish information reasonably available at the earlier decision point from knowledge produced afterward. This protects against simple hindsight substitution while still allowing later evidence to revise the assessment of consequences and institutional learning.

Intergenerational harm is a particularly important case. Present decisions can alter environmental conditions, infrastructure, debt, institutions, knowledge, and option structures inherited by later generations. The sustainable-development tradition has long emphasized relations between present development and the needs and capa-

bilities of future generations (World Commission on Environment and Development 1987). GRE adds a generative emphasis: what is transmitted forward includes not only stocks and liabilities but also capacities to regenerate, govern, learn, convert value, maintain institutions, and create alternatives.

Long-horizon harm can be cumulative without being immediately dramatic. Small maintenance deficits can compound. Persistent exposure can damage health or ecosystems. Repeated underinvestment can erode institutional competence. Successive losses of local knowledge can make later adaptation harder. Individual episodes may remain below a conventional threshold while their combined historical trajectory materially reduces resilience or future option space. Evaluation should therefore consider sequence and accumulation where the mechanism supports such analysis.

Discounting or present-value calculation can be useful for some financial and policy questions, but it cannot by itself resolve heterogeneous long-horizon harms. Ecological threshold loss, institutional collapse, cultural loss, capability deprivation, and irreversible option foreclosure may not share a defensible common monetary conversion. Where monetary comparison is used, the assumptions and omitted value forms should remain visible rather than being treated as settled equivalence.

Long-horizon analysis also creates a practical governance problem: current decision makers can impose costs on positions that cannot participate in present bargaining. This does not generate a single institutional solution, but it strengthens the case for explicit horizon specification, scenario analysis, reversibility, precaution where warranted, preservation of options, monitoring, and mechanisms that allow later revision as knowledge changes.

14.10.8 Irreversibility

Irreversibility concerns the feasibility of restoring an earlier condition, recovering a lost capability or relation, reopening a foreclosed option, or otherwise returning to a relevant prior region of the represented history space. The term should be used carefully. Many social and economic changes are difficult to reverse without being literally irreversible. GRE therefore distinguishes absolute irreversibility, which requires a strong domain-specific basis, from practical or horizon-relative irreversibility.

Definition 14.25 provides the working concept used in this chapter.

Definition 14.25 (Practical irreversibility)**.** A harmful change is *practically irreversible* relative to an affected position, evaluative standpoint, and time horizon when restoration of the materially relevant prior capability, relation, institutional condition, ecological function, or option is physically impossible, institutionally unavailable, or requires resources, time, coordination, or burdens that place restoration outside the practically reachable action space of the relevant position within that horizon.

This definition treats irreversibility as relational and historical. A lost capability can be recoverable for a wealthy organization but effectively irreversible for a resource-constrained household. An ecosystem can regenerate over centuries while remaining irreversible for the policy horizon under analysis. An institution can be

legally re-created while its lost legitimacy, tacit knowledge, or professional community cannot be restored on comparable terms. A displaced community can receive compensation without reproducing the earlier relational world. The analytical claim must therefore specify what is to be restored and for whom.

Irreversibility also differs from lock-in. Lock-in describes a self-reinforcing configuration in which switching becomes increasingly difficult under specified mechanisms. Some locked-in arrangements remain reversible at high cost. Conversely, some irreversible losses do not arise from increasing returns or lock-in at all. The destruction of unique ecological or archival conditions, death, or disappearance of tacit knowledge can be effectively irreversible without a self-reinforcing adoption process. Historical path dependence can nevertheless contribute to practical irreversibility where early choices alter later alternatives (Arthur 1989; Pierson 2000).

The evaluative significance of irreversibility depends on the value form and uncertainty. When an intervention risks reversible financial loss, later compensation or reallocation may remain possible. When it risks irreversible ecological, health, cultural, institutional, or option-space loss, the burden of uncertainty can be different because later correction may not reproduce what has been lost. This does not imply a universal rule against irreversible change. Development, innovation, migration, and institutional transformation often alter history in ways that cannot be exactly undone. The relevant question concerns the value and distribution of what becomes unavailable, the quality of evidence, available alternatives, and the possibility of protection, compensation, restoration, or justified transition.

The section's layered harm architecture is summarized in Proposition 14.26.

Proposition 14.26 (Layered diagnosis of negative value and harm)**.** *Within a GRE value analysis, a substantively adequate harm claim should identify, to the level warranted by the research problem, the negatively affected position, the relevant value form or generative condition, the adverse change, the evaluative standpoint, the causal or contributory mechanism, the distribution of burdens and protections, the temporal horizon, and the feasibility of restoration, exit, or alternative trajectories. Dissipation, leakage, extraction, dependency, constraint, path dependence, or irreversibility can strengthen a harm analysis when their mechanisms are established, but none of these categories alone is sufficient to settle the normative judgment.*

Proposition 14.26 preserves the distinction among empirical diagnosis, causal attribution, and evaluation. It also prevents negative value from becoming a universal scalar residue after positive value has been counted. Harm can be plural, distributed, delayed, relational, and partly incommensurable; its adequate representation depends on the question and on what materially changes for affected positions.

This conclusion provides the immediate bridge to the next section. Once harm and benefit are represented across heterogeneous value forms, affected positions, and historical horizons, evaluation often encounters conflicts that cannot be resolved through a single common unit. The next section therefore turns to plurality and incommensurability, examining multiple value orders, heterogeneous subjects, value conflict, translation among value forms, and the limits of monetization and aggregation.

14.11 Plurality and Incommensurability

The preceding sections developed value as plural in form, relationally emergent, historically generated, transmitted, converted, recirculated, accumulated, depleted, and capable of carrying both positive and negative significance. The present section establishes the evaluative architecture required once several value forms, evaluative standpoints, and affected positions coexist without a guaranteed common metric. Its role is to distinguish *plurality*, *comparison*, *commensuration*, *translation*, *conflict*, and *incommensurability*; its objective is to preserve practical judgment while preventing a convenient metric from silently becoming a theory of value. The discussion proceeds through multiple value orders, heterogeneous subjects, incommensurable values, value conflict, translation, monetization, aggregation, and the institutional preservation of plurality. The method is conceptual and comparative, drawing on already established traditions of value pluralism, commensuration studies, capability analysis, and practical reasoning while retaining GRE's ontological and historical restraint.

Plurality begins from a modest observation: economic processes can matter in several distinguishable ways. A river can carry ecological, livelihood, cultural, option, institutional, and financial significance. A school can generate capability, epistemic, relational, institutional, participatory, and future value. A digital platform can lower transaction costs while concentrating informational control and weakening exit. The existence of several evaluatively relevant dimensions does not by itself establish that they are incomparable. It establishes that comparison requires an operation whose assumptions should be visible.

This point is central because comparison and commensuration are often treated as synonyms. Espeland and Stevens define commensuration as the transformation or comparison of different qualities according to a common metric and show that this operation has cognitive, organizational, and political consequences (Espeland and Stevens 1998). GRE adopts a narrower analytical distinction. *Comparison* asks whether two alternatives can be judged in relation to specified concerns. *Commensuration* constructs or adopts a common metric through which some of those concerns are represented on a shared scale. Comparison can therefore occur without complete commensuration. A community can judge that one project creates unacceptable ecological loss despite higher forecast revenue; a court can treat a right as a constraint on otherwise advantageous exchange; a household can reject a higher-paying arrangement because it destroys care capacity. Such judgments can be reasoned without claiming that every relevant value has first been expressed in one unit.

Definition 14.27 provides the working vocabulary for the section.

Definition 14.27 (Value plurality, comparison, and commensuration)**.** Within a specified GRE analysis, *value plurality* exists when more than one analytically relevant value form, evaluative standpoint, or order of worth bears materially on the assessment of an object, relation, process, institution, or trajectory. *Comparison* is a reasoned relation among alternatives with respect to one or more stated criteria or standpoints. *Commensuration* is the construction or adoption of a common representational scale through which selected differences are rendered comparable in a shared metric. *Incommensurability* denotes the absence, inadequacy, or contested legitimacy

Table 14.11: Analytical architecture of plurality and incommensurability in GRE

Dimension	Analytical question	Legitimate operation	Principal remainder or risk
Multiple value orders	Which forms and evaluative grammars matter?	Explicit multi-dimensional representation	One order silently displacing others
Heterogeneous subjects	Whose valuation and incidence are represented?	Position-indexed comparison and contestation	Aggregated judgment concealing unequal burdens
Incommensurability	Is a defensible common metric available?	Partial order, thresholds, scenarios, deliberative judgment	Forced cardinalization or false precision
Value conflict	Which goods, obligations, or trajectories cannot be jointly realized?	Trade-off analysis with stated priorities and constraints	Treating conflict as mere measurement error
Translation	What is preserved or changed across value registers?	Provenance-preserving interpretation or conversion	Semantic compression and loss of context
Monetization	What can money represent adequately for the purpose?	Monetary valuation with explicit scope	Price becoming a claim of exhaustive value
Aggregation	What information may be combined?	Purpose-specific index, portfolio, or social evaluation	Distributional, relational, and structural information loss
Plural value architecture	How can decisions proceed while remainders stay visible?	Layered evaluation, partial rankings, safeguards, revisability	Procedural complexity or opaque discretionary judgment

of such a common metric for the values at issue; it does not by itself entail complete incomparability or the impossibility of practical judgment.

Definition 14.27 leaves open several possibilities. Two values can be commensurable for a narrow decision problem while remaining non-equivalent in a broader evaluative frame. A monetary representation can be informative for budgeting without exhausting ecological or institutional significance. Two alternatives can be partially ordered, judged above a threshold, or compared under distinct scenarios without producing a complete ranking. Philosophical discussions of incommensurability and incomparability similarly distinguish the absence of a common measure from the stronger claim that rational comparison is impossible (Raz 1986; Chang 1997). GRE therefore treats incompleteness as a possible property of an evaluation rather than as an analytical defect that must always be eliminated.

Table 14.11 summarizes the architecture developed below. Its rows are deliberately non-exclusive. A single valuation problem can involve several value orders, heterogeneous affected positions, translation across forms, monetization, aggregation, and unresolved remainder simultaneously.

14.11.1 Multiple Value Orders

A value form identifies a recurrent way in which economic significance is realized or represented. A *value order* adds an evaluative grammar: it specifies what counts as relevant, how claims acquire standing, what forms of evidence matter, which comparisons are legitimate, and what kinds of sacrifice or substitution are acceptable. The distinction matters because two actors can observe the same value form while evaluating it under different orders. Financial sustainability can be treated as a pru-

dential constraint, a distributive question, an institutional requirement, or a dominant objective; ecological value can be treated as an input, an intrinsic concern, an intergenerational obligation, or a boundary condition.

Plural orders therefore arise from more than a long list of goods. They arise because evaluative practices organize goods differently. Anderson's account of plural modes of valuation argues against reducing heterogeneous goods to a single market-like mode of appraisal (Anderson 1993). Lamont's sociology of valuation and evaluation similarly treats worth, categorization, legitimation, and judgment as socially organized processes rather than as expressions of an undifferentiated private preference scale (Lamont 2012). GRE draws on this lineage while keeping its scope economic: the question is how different orders of valuation shape economic generation, allocation, conversion, transmission, institutionalization, and harm.

Multiple value orders can coexist inside one institution. A university may evaluate research through epistemic contribution, educational contribution, public relevance, financial sustainability, institutional reputation, legal compliance, and career-development effects. These orders can reinforce one another, remain loosely coupled, or enter conflict. A ranking system may translate several of them into indicators; a budget may monetize selected components; a promotion committee may combine formal thresholds with qualitative judgment. None of these operations proves that the underlying orders were identical before the evaluation procedure was constructed.

The plurality of orders also changes what counts as a successful conversion. Financial resources converted into research infrastructure can generate epistemic value while also producing unequal capability access. Ecological restoration can produce material and community value while reducing short-term financial returns. A conversion can therefore appear successful under one order and incomplete under another. The source of disagreement may lie in factual beliefs, in the weighting of shared criteria, in the inclusion or exclusion of a value form, or in deeper disagreement over the legitimate order of evaluation. Distinguishing these sources prevents value disagreement from being described too quickly as irrationality.

Value orders can themselves be historically generated. Markets, professions, accounting systems, states, scientific communities, religious institutions, social movements, and technological platforms develop vocabularies and procedures through which certain things become visible as valuable. The legitimacy of a metric can therefore be historically contingent. What counts as a recognized externality, a compensable loss, a credential, an asset, a right, or a public obligation can change as institutions and subjects change. GRE consequently treats value orders as part of the relational architecture through which valuation occurs, while preserving the possibility that actors criticize or transform the orders they inherit.

14.11.2 Heterogeneous Subjects

Plural value analysis requires heterogeneous subjects as well as heterogeneous value forms. An evaluative object can affect persons, households, firms, communities, public institutions, future generations, and ecological systems differently. Even within a nominally homogeneous category, subjects can possess different capabilities, dependencies, histories, vulnerabilities, responsibilities, and relations. A single aggregate

welfare or price representation can therefore obscure whose value is realized, whose burden is increased, and whose options are altered.

Sen's capability approach provides an important precedent for this distinction by showing that equal resources can produce unequal substantive opportunities because persons differ in conversion conditions and social circumstances (Sen 1985; Sen 1992). GRE extends the same caution to plural value incidence. Equal monetary compensation does not imply equal restoration of relational, capability, ecological, or institutional value. Equal formal access does not imply equal participatory value. Equal exposure to a policy does not imply equal capacity to absorb risk or recover from loss.

Heterogeneous subjects also occupy different relational positions. A platform operator, dependent seller, consumer, regulator, and worker can participate in the same digital market while confronting very different switching costs, information, bargaining power, and exposure. A conservation project can create ecological value at a regional scale while imposing livelihood burdens on a local community. A hospital closure can improve system-wide accounting efficiency while reducing effective access for geographically or socially distant patients. In each case, an aggregate value claim can be informative only if its incidence boundary and subject composition are specified.

Heterogeneity does not require treating every person as analytically incomparable with every other. Shared needs, rights, capabilities, institutional roles, or common evaluative standards can support legitimate comparison. The methodological requirement is narrower: the aggregation unit should not erase heterogeneity that materially changes the conclusion. If two groups experience the same policy through different conversion conditions or risk structures, the analysis should preserve that difference to the level relevant to the question.

This also applies to representation. Subjects can value the same condition differently because of distinct histories, identities, responsibilities, or practical projects. Such variation need not be treated as mere preference noise. It can reveal that an object participates in different relations. A neighborhood park can be recreational space, flood infrastructure, ecological habitat, community memory, real-estate amenity, and a source of livelihood. The relevant evaluative subject is partly constituted by these relations. GRE therefore treats subject heterogeneity as a substantive component of value analysis rather than only as a parameter to be averaged out.

A further complication concerns absent or weakly represented subjects. Future generations cannot participate directly in present bargaining. Ecological systems do not articulate preferences in the same institutional manner as market actors. Marginalized groups may possess formal voice while lacking effective agenda-setting power. Representation procedures are consequently part of the valuation architecture. The question is not only what subjects value, but also which subjects acquire standing, whose evidence enters the decision, and who controls the categories through which harms and benefits become recognizable.

14.11.3 Incommensurable Values

Incommensurability becomes analytically relevant when a common metric is unavailable, analytically misleading, or normatively contested for the values at issue. This can occur because value forms differ in kind, because measurement scales do not support the proposed mathematical operation, because the relevant standpoint rejects substitution, or because converting one value into another would erase information that is constitutive of the judgment. The diagnosis is therefore local to a comparison problem rather than a universal property attached permanently to a good.

A first form is *measurement incommensurability*. Two dimensions may be measurable separately but lack a justified conversion rate. Health risk and cultural loss, for example, can each be described with evidence while resisting a defensible common cardinal unit. A second form is *normative incommensurability*: an evaluative framework can treat some values as inappropriate for unrestricted trade-off, even if a numerical proxy could technically be constructed. A third form is *institutional incommensurability*: different institutions can authorize different valuation procedures, rights, or thresholds, so that no single metric governs the whole case. These forms can overlap.

Incommensurability should be distinguished from incomparability. Raz's value pluralism and the philosophical literature collected by Chang demonstrate that the relation among plural values can be more complex than a complete common ranking (Raz 1986; Chang 1997). Some alternatives can be judged better or worse under a specified standpoint without being measured in common units. Others can be roughly comparable, threshold-comparable, or remain unresolved. A partial order can therefore be analytically sufficient.

This distinction permits decision without false precision. Suppose two infrastructure designs differ in cost, ecological disruption, resilience, local displacement, and long-term option value. A decision process can reject designs that violate a legal or ecological threshold, compare remaining options on financial and capability dimensions, examine distributional incidence, and preserve unresolved differences for deliberation. The procedure does not require a single master number. It requires explicit decision rules and an account of what remains outside each rule.

Incommensurability also has a temporal dimension. A present metric can be adequate for a current decision and become inadequate as institutions, knowledge, ecological conditions, or affected subjects change. Values that were once weakly recognized can acquire new standing. Conversely, new technologies can make previously incomparable outcomes more measurable without resolving normative disagreement. GRE therefore treats commensurability as historically situated and revisable rather than as a permanent discovery about the essence of a value form.

Finally, claims of incommensurability can themselves carry power. Declaring a value beyond comparison can protect it from commodification, but it can also remove trade-offs from public scrutiny or shield established institutions from evaluation. Declaring values commensurable can facilitate transparent budgeting, but it can also privilege actors who control the metric. The appropriate response is not a presumption for or against commensuration. It is explicit examination of what

the common metric represents, what it excludes, who authorizes it, and what consequences follow from using it.

14.11.4 Value Conflict

Value conflict occurs when relevant value claims cannot be jointly realized under the available resources, institutional rules, technological possibilities, temporal horizon, or relational configuration. Conflict is therefore distinct from plurality. Several values can coexist harmoniously; conflict appears when practical choice, sequence, or institutional design forces a sacrifice, constraint, or redistribution among them.

Some conflicts arise within a value form. Two groups can compete for the same scarce material resource. Others arise across forms: short-term financial value can conflict with ecological regeneration, privacy with data-enabled coordination, organizational efficiency with participatory value, or rapid deployment with epistemic caution. Still others concern incidence: an intervention can generate high aggregate value while concentrating harm on one population. These conflicts should be diagnosed before aggregation because the structure of the conflict can matter more than the final total.

A value conflict can be resolved in several analytically distinct ways. One value can be given priority by right, threshold, or institutional mandate. A compromise can reduce both claims. Sequencing can permit partial realization over time. Innovation can alter the feasible set and reduce the conflict. Compensation can address some incidence without restoring the sacrificed value. Deliberation can revise the parties' understanding of what is at stake. The existence of these different resolution mechanisms is another reason to avoid assuming that conflict is equivalent to a missing exchange rate.

Compensation deserves particular caution. Monetary or material compensation can be highly relevant even when values are incommensurable, because compensation can redistribute burdens, finance restoration, or acknowledge responsibility. Yet payment does not prove equivalence between the compensation and what was lost. A payment for relocation can improve financial capacity without reproducing community relations. Damages for environmental injury can finance remediation without restoring an extinct species. Compensation can therefore be justified as a remedial institution while leaving an evaluative remainder.

Conflict can also reveal hidden value orders. A policy that appears consensual under normal conditions can produce sharp disagreement when scarcity forces prioritization. Decisions about hospital capacity, climate adaptation, education, or research funding often make latent commitments visible: whose risk counts, which time horizon matters, whether resilience is valued over efficiency, and how uncertainty is allocated. GRE treats such episodes as evidence about valuation architecture rather than merely as failures to optimize.

A plural framework should also distinguish tragic conflict from ordinary trade-off. Some decisions leave a morally or institutionally significant remainder even after the most justified available choice is made. Recognition of such remainder can support memorialization, compensation, review, restoration efforts, or institutional learning. It prevents the selected option from being redescribed retrospectively as costless sim-

ply because a decision had to be made.

14.11.5 Translation among Value Forms

Translation among value forms is an interpretive operation that relates heterogeneous representations while attempting to preserve enough provenance for the relation to remain intelligible. It differs from conversion in Section 358. Conversion concerns how one value-bearing condition becomes practically effective in another form or domain. Translation concerns how claims expressed in one evaluative register are rendered understandable within another register for comparison, coordination, deliberation, or institutional action.

A public agency can translate ecological evidence into regulatory categories; a hospital can translate patient experience into quality indicators; a community can translate local knowledge into planning evidence; an organization can translate capability concerns into budget requests. Such translation can be indispensable because institutions require actionable categories. Yet translation also transforms what it represents. Tacit knowledge becomes documentation, qualitative experience becomes a score, ecological complexity becomes a risk class, and participatory demands become policy options. The translated representation can travel more easily while carrying less context.

Definition 14.28 provides the working concept.

Definition 14.28 (Value-form translation)**.** A *value-form translation* is a context-specific interpretive mapping through which a value claim expressed, realized, or evidenced in one evaluative register is rendered intelligible within another register for a specified analytical or institutional purpose. Adequate translation should preserve, to the degree material to that purpose, the source value form, affected position, evaluative standpoint, evidential basis, and any remainder that is compressed, contested, or not carried into the target representation.

Translation can succeed without establishing equivalence. A qualitative account of caregiving burden can be translated into staffing requirements without claiming that the burden is identical to the resulting budget line. Ecological risk can be translated into a regulatory threshold without implying that the threshold exhausts ecological value. An educational capability can be represented through several indicators without becoming identical to those indicators. Translation is therefore better understood as an interface between evaluative languages than as proof of common substance.

Translation can also be asymmetric. Some value orders possess institutional languages, datasets, professional experts, and established accounting categories; others enter decision processes only after substantial reinterpretation. This creates a translation burden. Communities may need to convert lived experience into administrative evidence, scientists into policy summaries, or care work into productivity categories before their claims receive standing. Control over translation interfaces can consequently shape whose values become actionable.

A provenance-preserving translation records what moved and what did not. It can state that a monetary estimate represents foregone income while excluding cultural loss; that an indicator captures access but not quality; that a survey measures

reported trust under a specific instrument; or that a legal category recognizes one dimension of harm. Such declarations do not weaken analysis. They make the representational operation inspectable and therefore more revisable.

14.11.6 Monetization and Residual Value

Monetization expresses selected value claims in monetary units. It can be indispensable for budgeting, compensation, investment comparison, accounting, pricing, insurance, and public decision. GRE therefore does not treat monetary valuation as inherently reductionist. Its adequacy depends on the question, the valuation procedure, the affected positions, and the remainder left outside the monetary representation.

The central analytical issue is scope. Market prices can summarize exchange conditions where markets exist, while shadow prices, willingness-to-pay methods, replacement-cost approaches, damages, and accounting conventions can create monetary representations where direct prices are absent. Each procedure answers a different question. Fourcade's study of economic valuation of nature shows that monetary valuation is socially organized through reasons for valuation, techniques, institutions, and feedback effects rather than through a neutral translation automatically supplied by the valued object (Fourcade 2011). The number therefore carries methodological and institutional provenance.

Monetization becomes misleading when a purpose-specific representation is treated as exhaustive value. Anderson's critique of monistic market valuation is relevant here: distinct goods can be appropriately valued through different social relations and evaluative modes (Anderson 1993). A monetary estimate of unpaid care can make its economic contribution visible without implying that care is adequately governed as a commodity. A biodiversity estimate can inform cost comparison while leaving ecological thresholds, uncertainty, and irreversibility outside the price. Compensation for rights violations can provide remedy while not establishing that the right itself had an exchange price.

The concept of *residual value* helps preserve this distinction. Residual value here does not mean a residual financial asset value. It denotes evaluatively relevant significance that remains outside or is compressed by the selected monetary representation. The remainder can include distribution, dignity, legitimacy, relational continuity, ecological function, option value, institutional trust, or uncertainty. Which remainder matters depends on the problem.

Monetization can also alter behavior. Once a value is expressed financially, organizations can optimize against the monetary representation, compare it across projects, or incorporate it into contracts. This can improve accountability, but it can also change the social meaning and practical governance of the valued object. Commensuration studies emphasize that metrics can reshape categories and action, rather than merely describe pre-existing differences (Espeland and Stevens 1998). GRE therefore treats monetization as an intervention in valuation architecture as well as a measurement operation.

A disciplined monetary analysis should accordingly state what the monetary figure represents, how it was produced, whose valuation entered, which uncertainties matter, what non-monetized dimensions remain material, and how the figure will be

used. This preserves the practical strengths of monetary representation while preventing it from silently becoming an ontological or normative totalization.

14.11.7 Aggregation and Information Loss

Aggregation combines observations, value claims, indicators, persons, groups, times, or dimensions into a higher-level representation. Like monetization, it is often necessary. Governments allocate budgets across populations, organizations construct dashboards, researchers summarize distributions, and households compare multi-period plans. The analytical problem is not aggregation itself but the information that aggregation removes and whether the removed information is material to the decision.

Aggregation can occur within a value form without requiring cross-form commensuration. Financial totals combine monetary quantities; a capability dashboard can summarize several indicators while keeping them separate; ecological accounts can combine measurements that share defensible units. Cross-form aggregation imposes stronger assumptions. A composite index that combines income, health, participation, and ecological quality requires normalization, weighting, and aggregation rules. These rules can be transparent and useful, but the resulting index should be understood as a constructed evaluative representation.

Distributional information is one major remainder. Two societies can have the same aggregate income while distributing it differently. Two programs can generate the same total capability gain while benefiting different populations. A project can produce positive aggregate value while imposing irreversible loss on a small group. Aggregation can therefore conceal incidence even when every underlying measurement is accurate.

Relational and structural information is another remainder. Network position, dependency, concentration, institutional authority, and conversion access cannot always be recovered from totals. Ten organizations with equal aggregate resources can occupy very different relational structures. A system can maintain total output while losing redundancy and becoming fragile. A community can receive the same total funding after a reform while losing local decision authority. When such structures matter, aggregation should be supplemented by relational representation.

Temporal aggregation can likewise obscure sequence. The same cumulative expenditure can produce different outcomes depending on timing, staging, recurrence, and lock-in. The same average ecological burden can conceal threshold breaches. The same long-run mean employment can hide repeated episodes of insecurity concentrated on particular subjects. GRE's historical orientation therefore treats sequence and duration as potential parts of value incidence rather than assuming that temporal totals are sufficient.

Incomplete aggregation can sometimes be a feature rather than a deficiency. Sen's capability framework deliberately resists forcing every evaluative dimension into one final utility metric, and operational capability work has examined plural and incomplete evaluation rather than treating completeness as a prerequisite for action (Sen 1992; Alkire 2002). A decision maker can work with a dashboard, dominance relations, thresholds, scenario ranges, or a set of non-dominated alternatives. Such

representations preserve more information at the cost of less immediate simplicity.

Aggregation should therefore be justified by analytical purpose. The question is which distinctions can be safely compressed and which must remain recoverable. A good aggregate is not the one that contains everything; no finite representation can do so. It is one whose losses are known and whose retained structure is adequate to the decision being made.

14.11.8 Plural Value Architecture

Preserving plurality does not require refusing decisions until every value conflict has disappeared. It requires decision architectures capable of acting while keeping materially relevant heterogeneity, disagreement, uncertainty, and remainder visible. GRE therefore treats plural evaluation as an institutional design problem as well as a conceptual one.

Several decision forms are compatible with plural value. A *threshold architecture* can establish minimum conditions that alternatives must satisfy before further comparison. A *partial-order architecture* can identify dominance where it exists while leaving some pairs unresolved. A *lexicographic architecture* can give specified values priority under explicitly justified conditions. A *portfolio architecture* can preserve several value dimensions and seek diversification rather than one maximand. A *deliberative architecture* can combine evidence and reason-giving where weights cannot be defensibly fixed in advance. These approaches can also be combined.

Institutional pluralism creates its own risks. Too many indicators can overwhelm decision makers. Vague appeals to complexity can conceal discretionary power. Deliberation can reproduce inequalities in voice. Multiple veto points can freeze adaptation. Preserving plurality therefore requires procedural discipline: clear standing rules, transparent evidence, reasons for weighting or priority, documentation of unresolved remainder, contestability, and revision mechanisms. Complexity should serve analytical adequacy rather than become an excuse for opacity.

Plural architecture also benefits from separating *decision closure* from *value closure*. Institutions sometimes have to choose one option by a deadline even when the evaluative ordering remains incomplete. A decision can therefore close the immediate action problem while leaving the value analysis open to review. Recording unresolved harms, minority assessments, uncertain ecological effects, or contested weights preserves information for later monitoring, compensation, restoration, or policy revision.

This separation is especially important near irreversibility. Where one alternative can foreclose future options, decision architecture can assign special weight to reversibility, preservation of option space, or monitoring even when no common metric settles the entire comparison. Such safeguards do not imply that reversibility is always the highest value. They respond to an asymmetry in correction: errors in reversible decisions can often be revised, while errors involving irreversible loss can remove later opportunities for learning.

The same logic applies to democratic and organizational legitimacy. A plural value process should make visible whose evaluations entered the decision and whose were

excluded. Participatory procedures do not automatically produce correct valuations, but they can reveal dimensions that centralized measurement missed. Expert judgment can add technical knowledge without replacing affected subjects' experience. Markets can reveal willingness to pay under specified conditions without exhausting social value. Law can define rights or constraints without resolving every policy trade-off. Plural architecture uses these institutions as partially complementary modes of valuation rather than treating one as the universal tribunal.

Proposition 14.29 summarizes the section's discipline.

Proposition 14.29 (Adequacy of plural value evaluation)**.** *Within GRE, an evaluation involving heterogeneous value forms or affected positions is adequate to the degree warranted by the research problem when it identifies the relevant value orders and subjects, distinguishes comparison from commensuration, states any translation, monetization, weighting, or aggregation procedure used, preserves materially relevant distributional and relational incidence, records significant residual or incommensurable claims, and provides an explicit decision rule or institutional procedure where action is required. Completeness of cardinal measurement is therefore not a general precondition for reasoned comparison, decision, or later revision.*

Proposition 14.29 does not make plurality an end in itself. Some distinctions can be legitimately simplified; some metrics are robust; some value conflicts can be resolved through evidence or institutional agreement. The proposition instead places the burden of justification on the operation that removes heterogeneity. Where monetization, weighting, aggregation, or translation materially changes the evaluative conclusion, that operation becomes part of the analysis rather than invisible technical background.

The section also clarifies the transition to valuation and measurement. Once plural values and their possible incommensurability are acknowledged, the practical question becomes how indicators, proxies, prices, accounts, capability measures, relational measures, epistemic measures, and option-space measures can represent these values without claiming more than their methods support. The next section develops that representational problem directly.

14.12 Valuation and Measurement

The preceding sections established that value in GRE can be plural in form, relationally emergent, historically generated, transmitted, converted, recirculated, accumulated, depleted, and only partially commensurable. The present section addresses the representational problem that follows from this architecture: how economically relevant value-bearing conditions can be made observable, comparable, administratively legible, or practically actionable without identifying the representation with the condition represented. Its role is to distinguish valuation from measurement and to clarify the analytical standing of indicators, proxies, prices, accounts, capability measures, relational measures, epistemic measures, and option-space measures. Its objective is to preserve the usefulness of measurement while keeping measurement error, representational remainder, reactivity, and historical revisability visible. The method is conceptual and comparative, drawing on existing work on valuation, com-

mensuration, capabilities, accounting, and the social effects of public measures, while retaining GRE's methodological pluralism and ontological restraint.

Valuation and measurement overlap, but they are not identical operations. Valuation attributes or recognizes significance under an evaluative standpoint. Measurement constructs a representation according to a specified protocol. A household can value continuity of care without assigning it a number. A statistical agency can measure household expenditure without thereby measuring every value realized through that expenditure. A market price can provide precise information about an exchange relation while leaving unrepresented capability, ecological, relational, or institutional effects. Dewey's account of valuation is useful here because it treats valuation as situated activity rather than as discovery of a fixed value substance (Dewey 1939). Studies of commensuration similarly show that measurement systems can transform qualitative difference into common metrics and thereby alter the objects and practices being compared (Espeland and Stevens 1998).

GRE therefore treats measurement as an epistemic and institutional interface. It can improve discrimination, coordination, accountability, learning, and comparison. It can also compress heterogeneity, privilege what is readily observable, and reorganize behavior around the measure. The question is consequently not whether measurement is intrinsically adequate or inadequate. The relevant questions are what is being represented, for which purpose, through which protocol, with what evidence, at what historical moment, and with which materially relevant remainder.

Definition 14.30 establishes the working distinction used throughout the section.

Definition 14.30 (Measurement representation)**.** Within a specified GRE analysis, a *measurement representation* is a rule-governed representation of one or more value-bearing conditions, relations, processes, or consequences for a stated analytical, administrative, comparative, or evaluative purpose. The representation may be quantitative, ordinal, categorical, relational, spatial, temporal, qualitative, or mixed. Its adequacy is assessed relative to the object represented, the protocol used, the decision or inquiry it serves, and the materially relevant information it preserves or omits.

Definition 14.30 deliberately leaves open whether a particular value form admits cardinal measurement. A financial balance can be represented in currency units; institutional legitimacy may require survey, behavioral, procedural, and interpretive evidence; a practical option space may be represented as a set of reachable alternatives or as a partial-order structure; ecological significance can require multiple biophysical and social indicators. A refusal to force these representations into one metric is compatible with rigorous measurement. The central requirement is provenance: the reader should be able to recover what the measure stands for and what transformations were required to construct it.

A compact structural formalization is useful for keeping this distinction explicit. The measurement map is stated in Equation 14.7.

$$\mathsf{M}_{\pi,t} : \mathcal{V}_f \times \mathcal{C}_t \longrightarrow \mathcal{R}_{\pi,t} \tag{14.7}$$

In Equation 14.7, $\mathcal{V}_f$ denotes a representation space for a value-bearing condition associated with value form f, $\mathcal{C}_t$ denotes the relevant historical and contextual condi-

Table 14.12: Analytical architecture of valuation and measurement in GRE

Representation	Primary analytical use	What it can make legible	Principal remainder or risk
Indicator	Track a selected dimension	Level, rate, status, threshold, trend	Indicator treated as the underlying value itself
Proxy	Represent a less observable condition	Indirect evidence correlated with the target	Proxy relation unstable, partial, or context dependent
Price	Represent an exchange relation	Marginal exchange terms under specified market conditions	Non-market incidence and background conditions omitted
Accounting	Organize recognized stocks and flows	Resources, obligations, transactions, positions, changes	Recognition rules defining the represented boundary
Capability measure	Represent substantive opportunity	Functionings, effective freedoms, conversion conditions	Latent or collective capabilities compressed
Relational measure	Represent economically consequential relations	Connectivity, reciprocity, dependence, maintenance, position	Relation quality reduced to topology or frequency
Epistemic measure	Represent epistemic standing or process	Accuracy, reliability, provenance, uncertainty, access	Goodhart-like optimization or contested standards hidden
Option-space measure	Represent reachable alternatives	Diversity, accessibility, reversibility, reachability	Nominal options mistaken for practical options
Error profile	Diagnose representational limits	Bias, noise, missingness, classification, model dependence	Error reduced to a single statistical residual
Historical revision	Reassess a measure over time	Changed evidence, categories, baselines, and relevance	Retrospective standards projected uncritically backward

tions at time t, π denotes the measurement protocol, and $\mathcal{R}_{\pi,t}$ denotes the representational range produced by that protocol. The range may contain numbers, categories, ranks, network positions, narratives, or mixed evidence. Equation 14.7 is a structural formalization rather than a claim that value is literally a mathematical object. Its purpose is to make visible that a measure depends on a protocol and context and therefore should not be silently substituted for the value-bearing condition itself.

Table 14.12 summarizes the principal representational interfaces developed below. The rows are non-exclusive. A policy evaluation, for example, may combine prices, administrative accounts, capability indicators, relational evidence, and option-space analysis.

14.12.1 Indicators

An indicator is a deliberately selected representation intended to make some aspect of a value-bearing condition observable or trackable. Indicators can be scalar, categorical, composite, spatial, temporal, or relational. Their usefulness follows from reduction: they make a complex condition legible enough for comparison, monitoring, coordination, or decision. The same reduction creates the principal analytical risk. An indicator can become mistaken for the condition it was designed to represent.

The distinction between a target condition and its indicator is especially important in a plural-value framework. School attendance can indicate educational participation while leaving learning quality, capability formation, relational inclusion, or later option generation only partially represented. A hospital waiting-time indicator can reveal an access bottleneck while omitting care quality or the distribution of delay across patients. A biodiversity index can track selected ecological dimensions without exhausting ecological value. The narrower representation may nevertheless be adequate when the research question is correspondingly narrow.

Indicator design therefore requires at least four explicit choices. The first is the *target*: which condition is the indicator meant to represent? The second is the *selection rule*: why does this observable bear on that target? The third is the *boundary*: which positions, times, spaces, or cases enter the measurement? The fourth is the *decision function*: how will the indicator be used? An indicator that is adequate for descriptive monitoring can be inadequate for resource allocation if small differences around a threshold produce large consequences.

Public indicators can also become part of the process they measure. Espeland and Sauder show how rankings can change organizational behavior through reactivity, commensuration, and self-fulfilling mechanisms (Espeland and Sauder 2007). GRE generalizes the analytical lesson without assuming that every measure is strongly performative. When actors know that an indicator affects funding, reputation, eligibility, or sanctions, they may reorganize activity around the indicator. Measurement then becomes an epistemic event and an institutional intervention as well as an observation.

This possibility does not make indicators unusable. It changes the validation question. Analysts should ask whether behavior induced by the indicator moves the underlying target in the intended direction, merely improves the measured score, or produces mixed effects across value forms. A publication-count indicator may stimulate output while shifting attention away from harder-to-measure research quality. A service-speed indicator may reduce delay while encouraging exclusion of complex cases. Such effects belong to measurement incidence rather than being treated as external to measurement design.

14.12.2 Proxies

A proxy represents a target condition through another observable believed to carry informative relation to it. Proxies become necessary when the target is latent, costly to observe, temporally delayed, conceptually plural, or inaccessible at the relevant scale. Income can sometimes proxy command over resources; educational credentials can proxy selected skills or institutional recognition; citation counts can proxy some dimensions of scholarly uptake; network centrality can proxy selected aspects of relational position. The analytical issue is not whether proxying occurs, but whether the proxy relation remains defensible for the purpose at hand.

A proxy relation can fail in several ways. The observable may correlate with the target in one population and not another. Institutional change can alter the relation between proxy and target. Strategic behavior can improve the proxy without changing the underlying condition. The proxy may capture only one component of a plural target. A measure initially designed as a rough approximation can also become institutionally entrenched and later be interpreted as if it were a direct observation.

GRE therefore treats a proxy claim as a conditional evidential relation. A well-specified proxy should state the target, the observable, the mechanism or empirical basis linking them, the population and historical range over which the relation is expected to hold, and the uncertainty or remainder that matters for interpretation. Where these conditions are weak, the proxy can still be useful as a screening device or exploratory indicator, provided its epistemic standing is preserved.

Proxy use becomes particularly consequential when it interacts with allocation. If a proxy determines eligibility, funding, credit, admission, or regulatory attention, representation error becomes distributed incidence. False positives and false negatives can affect different subjects asymmetrically. A proxy that is statistically adequate on average can therefore remain institutionally problematic if its errors systematically burden already constrained positions or if affected subjects lack practical means of contestation.

The relation between proxies and plural value also requires caution. A financial proxy for ecological damage, a test score for learning, or a reputation metric for institutional quality can support comparison while leaving residual value visible. The existence of residual value does not invalidate the proxy. It limits the inference that can legitimately be drawn from it.

14.12.3 Prices

Prices are among the most information-dense measurement interfaces in economic analysis. A price records an exchange relation expressed in a monetary unit under particular market, institutional, temporal, and bargaining conditions. It can coordinate decentralized activity, support accounting, enable comparison, and reveal scarcity or willingness to exchange under specified assumptions. GRE retains these uses while distinguishing price from exhaustive valuation.

The difference follows directly from the plural-value architecture. A price can measure what was exchanged without measuring every condition that made exchange possible or every consequence produced by the exchange. Property rights, market access, liquidity, bargaining power, information, legal enforceability, ecological background conditions, and outside options affect observed prices. Some value-bearing conditions are not traded; some are jointly produced; some affect third parties; some are institutionally prohibited from sale; and some are intentionally protected from market valuation. Fourcade's study of environmental valuation demonstrates how monetary valuation depends on institutional and cultural arrangements rather than simply revealing a pre-existing natural price (Fourcade 2011).

This does not require treating prices as socially arbitrary. A price can be highly informative within the exchange architecture that generates it. The analytical discipline is to preserve that architecture. A market price is evidence about a market relation; it may also serve as an input into broader valuation, cost analysis, or resource planning. The inferential error arises when the price is silently promoted from one representation of value to a complete measure of value.

Prices also interact with measurement through monetization. Section 14.11.6 introduced residual value as economically relevant significance that remains outside or is compressed by a monetary representation. The present section adds that residual value can change over time as market institutions, scarcity, rights, technologies, or social practices change. Historical price series therefore require interpretation of both the numerical movement and the changing institutional conditions under which the prices were formed.

For GRE, price measurement is strongest when used with explicit incidence. The same price change can produce different consequences across buyers, sellers, work-

ers, creditors, communities, or future subjects because endowments, capabilities, dependence, and alternatives differ. Price remains a central measurement interface, while the economic analysis can widen when those heterogeneous consequences materially affect the research question.

14.12.4 Accounting

Accounting constructs organized representations of recognized stocks, flows, obligations, transactions, positions, and changes over specified periods and institutional boundaries. Its economic importance lies partly in disciplined selectivity. An account defines what entity is being represented, what qualifies for recognition, how items are classified, when changes are recorded, and which valuation conventions apply. These rules make complex activity legible for governance, planning, taxation, reporting, comparison, and accountability.

The System of National Accounts provides a prominent macroeconomic example. It defines institutional units, sectors, transactions, stocks, and accounting identities through a standardized statistical architecture (European Commission et al. 2009). GRE can use such systems without treating their boundaries as natural ontological divisions. An accounting boundary is a representational decision shaped by the purpose of the account. Household labor, ecological depletion, informal care, institutional trust, or future option loss can be economically consequential even when a particular account does not recognize them as assets, liabilities, output, or expenditure.

The same principle applies at organizational scale. Financial accounts can represent cash, receivables, liabilities, recognized assets, depreciation, and income with high precision while leaving capability formation, network dependence, institutional legitimacy, or ecological exposure only partially represented. Supplementary accounts or non-financial reporting can widen the represented field, although each additional measure introduces its own definitions and evidential requirements.

Accounting should therefore be understood as a governed representational architecture rather than a neutral container into which all economic value naturally fits. Recognition rules matter because what appears in an account can affect borrowing, investment, regulation, managerial attention, and public judgment. Exclusion from an account does not establish economic irrelevance; inclusion does not establish normative desirability.

GRE's distinctive contribution is to connect accounting boundaries with value processes. A transaction can be accurately recorded at transfer while later capability formation, relational dependence, ecological depletion, or institutional return unfolds outside the reporting period or entity boundary. The accounting record remains correct for its stated purpose, while a broader generative analysis traces additional incidence when it becomes materially relevant.

14.12.5 Capability Measures

Capability measures seek to represent substantive opportunity: what persons or collectives are effectively able to do, become, access, or sustain. Their inclusion is nec-

essary because resources and incomes do not convert uniformly into effective freedoms. Sen's capability framework makes this distinction foundational by separating commodities and resources from functionings and capabilities (Sen 1985; Sen 1992; Sen 1999). The Human Development Report institutionalized a multidimensional measurement tradition that deliberately widened attention beyond output and income (United Nations Development Programme 1990), while Alkire develops practical methods for identifying and evaluating capability dimensions under conditions of plural value (Alkire 2002).

Capability measurement poses a distinctive representational problem because capability is partly counterfactual. Observed functioning records what occurred; capability concerns what was genuinely available. Two persons can exhibit the same functioning while possessing different opportunity sets. A person may fast by choice or because food is inaccessible. A worker may remain in a job by preference or because alternatives are practically absent. Measurement therefore needs evidence about conversion conditions, alternatives, constraints, and agency in addition to observed outcomes.

GRE extends capability measurement in three directions. First, it includes collective and relational capacities where the relevant ability is not reducible to an individual's attributes. A research team, community institution, mutual-aid network, or public administration can possess capacities that arise only through organized relations. Second, it connects capability measurement to generative opportunity: some capabilities matter because they allow subjects to produce or preserve additional future capacities and options. Third, it treats capability measurement as historically revisable because the technologies, institutions, and social conditions required to exercise a capability can change.

The measurement implication is that capability indicators should distinguish resources, conversion factors, observed functionings, effective alternatives, and relevant constraints where the research question requires that resolution. A simple indicator can remain useful, but its inferential domain should be stated. School completion, for example, can represent an educational milestone without being treated as a complete measure of epistemic capability, civic participation, employability, or later option space.

Capability measures also raise selection questions. Which capabilities enter the analysis, who participates in defining them, and whether weights are fixed or context dependent are substantive choices. GRE does not supply a universal list through this chapter. It requires the measurement architecture to preserve the evaluative provenance of the selected dimensions and to keep materially relevant exclusions visible.

14.12.6 Relational Measures

Relational measures represent economically consequential properties of relations or relational positions. Depending on the object, relevant dimensions can include connectivity, frequency of interaction, reciprocity, dependence, trust, maintenance burden, brokerage, replaceability, communication quality, authority, access, or practical exit. A network representation can reveal topology and position; a survey can rep-

resent perceived trust or reciprocity; administrative records can reveal repeated exchange; qualitative inquiry can recover meanings, obligations, or maintenance work that are poorly represented by edge counts.

The analytical difficulty is that relations have both structural and qualitative dimensions. Two actors can have the same number of connections while occupying very different positions in authority, dependence, or trust. A dense network can support coordination in one setting and exclusion in another. Frequent interaction can indicate cooperation, surveillance, conflict, or dependence. Relational measurement therefore requires interpretation of what the relation means and what function the measured property performs.

GRE consequently resists the reduction of relational value to network centrality or tie frequency. Such measures can be useful for specified questions, especially when the mechanism concerns reach, brokerage, redundancy, or structural dependence. They become less adequate when the research question concerns legitimacy, care, trustworthiness, contestability, or the quality of mutual recognition. Mixed measurement architectures can be preferable where structural and experiential evidence illuminate different aspects of the same relation.

Relational measures also have incidence effects. Once institutions measure collaboration, engagement, reputation, or connectivity, actors can reorganize relations to improve the measured representation. This can produce productive coordination, superficial networking, strategic signaling, or exclusion of difficult-to-measure relations. The measure therefore participates in the relational field it represents, particularly when attached to allocation or status.

A further issue concerns boundary choice. A measure of organizational collaboration can change substantially depending on whether informal ties, cross-sector links, international relations, or digitally mediated interactions are included. Boundary sensitivity should be treated as part of measurement provenance rather than as a technical nuisance to be hidden after model construction.

14.12.7 Epistemic Measures

Epistemic measures represent properties of knowledge, evidence, inquiry, information environments, or epistemic position. Relevant dimensions can include accuracy, reliability, uncertainty, provenance, reproducibility, predictive performance, explanatory fit, coverage, timeliness, access, interpretability, and the distribution of epistemic authority. Because these properties are heterogeneous, a single score rarely captures the whole epistemic condition relevant to economic action.

The distinction between information volume and epistemic value is central. More data can improve discrimination while also increasing noise, privacy burden, model dependence, or organizational complexity. A highly accurate model can remain institutionally unusable if its outputs cannot be interpreted or contested. A transparent process can be epistemically valuable even when it produces less precise point estimates because it allows error sources and assumptions to be examined. Epistemic measurement should therefore be indexed to the role evidence is expected to play.

GRE also distinguishes measuring epistemic output from measuring epistemic po-

sition. The first concerns the standing of a claim, model, dataset, or inquiry process. The second concerns who can access evidence, generate recognized knowledge, challenge a classification, or have testimony treated as credible. An institution can possess high-quality information while distributing epistemic authority asymmetrically. Measures of accuracy alone would then miss a materially relevant part of the epistemic economy.

Measurement can again be reactive. When publication counts, benchmark scores, forecasting accuracy, audit metrics, or model performance become targets, inquiry can reorganize around the metric. Such reactivity need not invalidate the measure. It means that the institutional consequences of measurement should enter the analysis where they affect epistemic quality, research direction, access, or incentives.

For epistemic measures, uncertainty should be represented rather than treated as a defect to be suppressed whenever possible. Confidence intervals, scenario ranges, sensitivity analyses, competing models, qualitative uncertainty descriptions, or explicit unknowns can be parts of a rigorous measurement architecture. The appropriate form depends on the evidence and decision problem. False precision is itself an epistemic error when the underlying evidence does not support the represented certainty.

14.12.8 Option-Space Measures

Option-space measures represent the alternatives that remain practically reachable to a subject, collective, institution, or system. Their role is to make visible a class of value that outcome measures can miss: the significance of preserved flexibility, exit, reversibility, diversification, and future pathways. An intervention can produce a favorable current outcome while narrowing later alternatives; another can generate modest current benefits while preserving valuable capacity to adapt.

The simplest option-space measure may count available alternatives. This is often insufficient. Alternatives differ in accessibility, cost, compatibility, risk, reversibility, and the capacities required to realize them. Ten nominal options can provide less practical opportunity than two genuinely reachable and supportable alternatives. GRE therefore distinguishes *nominal option count* from *effective option structure*.

A richer representation can describe reachability relations among states or actions. Some options are available immediately; others become reachable only after prerequisite actions, institutional approvals, learning, or investment. Some choices preserve later branching while others create lock-in. A partial-order or network representation can therefore be useful when sequence and dependence matter. Such formal representations remain model-relative and should not be interpreted as literal maps of every possible future.

Option-space measures also need subject and collective indexing. A policy can expand the option space of firms while narrowing household options; a technology can expand individual consumer choice while concentrating institutional control over standards; a conservation measure can restrict current extraction while preserving ecological and intergenerational options. Aggregate statements about “more choice” can conceal these redistributions.

The measurement problem becomes especially difficult under deep uncertainty because unknown future alternatives cannot be enumerated. In such cases, proxy dimensions such as modularity, reversibility, diversity, spare capacity, rights of exit, interoperability, ecological resilience, or institutional revisability may provide evidence about option-preserving conditions. These remain proxies rather than direct measurements of every future possibility. Their adequacy depends on a stated mechanism linking them to practical future reachability.

14.12.9 Measurement Error

Measurement error in GRE includes more than numerical noise around a true scalar value. Because value-bearing conditions can be plural, relational, historical, and only partially commensurable, representation can fail through several distinct mechanisms. Sampling error, recording error, classification error, missingness, model misspecification, proxy failure, boundary error, temporal mismatch, strategic response, aggregation loss, and category change can all produce materially different distortions.

This motivates an *error profile* rather than a universal error term. An error profile identifies the main ways in which the measurement can diverge from the condition or question it is intended to represent. For a price index, substitution and quality change may matter. For a capability measure, unobserved alternatives and conversion factors may matter. For a network measure, missing ties and boundary definition may matter. For an institutional-trust indicator, response interpretation, population composition, and changing expectations may matter.

The distinction between random and structured error is especially important. Random noise can reduce precision. Structured error can alter who is seen, ranked, funded, sanctioned, or excluded. When measurement enters allocation, classification, or eligibility systems, error becomes an incidence problem. The analyst should therefore examine not only average predictive or descriptive performance but also whether representation failure is systematically associated with particular positions, contexts, or value forms.

Measurement error can also arise from conceptual under-specification. A perfectly recorded indicator can answer the wrong question. If a measure of “access” records geographic proximity while practical access depends on language, cost, legal status, disability, or institutional eligibility, the technical measurement may be precise while the construct representation is incomplete. Precision should therefore be distinguished from validity relative to the analytical object.

GRE does not require elimination of every representational remainder before measurement can be used. That standard would often make practical inquiry impossible. It requires proportional disclosure: errors and omissions that can materially change interpretation, comparison, or decision should remain visible, while negligible remainder need not dominate the analysis.

14.12.10 Historical Revisability

Measurement systems are historically situated. Categories, baselines, technologies, institutions, scarcity conditions, legal definitions, and practical concerns change over time. A measure that was informative under one configuration can become less adequate when the relation between representation and target changes. Historical revisability is therefore a condition of responsible measurement rather than an admission that measurement is arbitrary.

Several forms of revision should be distinguished. *Data revision* changes the observations as better evidence becomes available. *Method revision* changes the procedure through which the representation is constructed. *Category revision* changes what is being classified or counted. *Baseline revision* changes the comparative reference point. *Evaluative revision* changes which dimensions are considered relevant to judgment. These revisions have different consequences for time-series comparability and historical interpretation.

Revisability creates a tension between continuity and adequacy. Stable measures support comparison across time; revised measures can better represent changed reality. Statistical and accounting systems often manage this tension through backcasting, parallel series, methodological notes, or explicit breaks. GRE generalizes the principle: where a representation changes, the provenance of the change should be preserved so that later users can distinguish a change in the underlying condition from a change in the measuring system.

Historical revision also raises an epistemic-fairness problem. Later analysts may possess evidence, categories, or measurement technologies unavailable to earlier actors. Re-evaluation can legitimately use improved knowledge while still distinguishing what could reasonably have been measured or known at the earlier decision point. This temporal discipline parallels the historical evaluation developed in the preceding chapter.

Measures can furthermore become constitutive of institutional history. Once embedded in budgets, rankings, eligibility rules, contracts, or performance systems, a measure can shape the practices it later records. Revision may therefore alter incentives, rights, reputations, and resource flows rather than merely improve observation. The costs and distributional consequences of measurement change can be part of the revision decision.

Proposition 14.31 summarizes the section's scope principle.

Proposition 14.31 (Representation adequacy and historical revisability)**.** *Within a GRE analysis, a valuation or measurement representation is adequate when it preserves the distinctions and evidence materially necessary for the stated inquiry or decision, identifies the relevant protocol and boundary, and keeps consequential error or remainder visible. Adequacy does not require exhaustive representation of every value form. Where the relation between representation and target changes because evidence, institutions, technologies, categories, or historical conditions change, the representation should remain revisable with sufficient provenance to distinguish revision of the measure from change in the represented condition.*

Proposition 14.31 protects both simplification and critique. Narrow measures can be analytically strong when they answer narrow questions. Broader measurement

becomes appropriate when omitted capability, relational, epistemic, ecological, institutional, distributional, or option-space effects materially alter the conclusion. Measurement therefore enters GRE as disciplined representation rather than as a final ontology of value. The following section can build on this distinction by examining generative return: the ways in which value-bearing effects return to later processes and the evidential problems involved in attributing such return across heterogeneous forms and time horizons.

14.13 Generative Return

This section develops generative return as a value-process concept within GRE. Its role is to specify how value-bearing effects produced through an earlier economic process can re-enter later processes as conditions of further generation, maintenance, coordination, adaptation, or transformation. The objective is to distinguish such return from ordinary financial yield, simple recirculation, and retrospective claims that an earlier intervention was valuable merely because some later benefit appeared. The discussion proceeds through immediate, relational, capability, epistemic, institutional, option-space, and long-horizon return before examining attribution under uncertainty. The method is analytical and historical: each form of return is indexed to a source process, affected positions, value form, re-entry pathway, time horizon, and evidential basis, while heterogeneous returns remain only partially commensurable.

The preceding chapter introduced generative return in the narrower context of allocation-mediated effects. Chapter 14 broadens the concept. A generative return can arise from production, learning, cooperation, institutional formation, ecological restoration, research, infrastructure, care, maintenance, or another value-generating process. The relevant feature is recursive re-entry. An effect generated in one episode later becomes materially relevant to another episode rather than terminating with the original transaction or outcome.

This broader use of *return* should be distinguished from several neighboring ideas. A financial return records a gain relative to a financial position under a specified accounting convention. Recirculation concerns the re-entry of value-bearing conditions into later processes and can occur even when no evaluative claim about the resulting condition is made. Generative return adds a value-analytic question: what economically significant capacity, relation, knowledge, institution, option, ecological condition, or other value-bearing effect has returned to later generative activity, for whom, through which pathway, and under which evaluative standpoint? Return can therefore be distributed, delayed, transformed across value forms, or partly appropriated by positions different from those that contributed to its generation.

The concept also requires restraint. Later value does not by itself establish return from an earlier process. Attribution needs a plausible pathway connecting the earlier episode to the later value-bearing condition. The pathway may involve transmission, conversion, recirculation, accumulation, institutional persistence, learning, or another mechanism developed in preceding sections. The further the return lies from the source in time, organizational distance, or causal complexity, the more important

Table 14.13: Analytical dimensions of generative return in GRE

Return dimension	**Primary object**	**Diagnostic question**
Immediate	Near-term usable effect	What generated condition becomes practically available within the active episode or its immediate continuation?
Relational	Relation or coordination condition	Which ties, trust structures, reciprocal capacities, or governance relations later support action?
Capability	Effective ability to act	Which learned, embodied, technical, organizational, or collective capacities become usable later?
Epistemic	Knowledge and epistemic infrastructure	Which evidence, models, memory, interpretive resources, or inquiry capacities re-enter later decisions?
Institutional	Durable rule or organizational capacity	Which procedures, rights, routines, infrastructures, or legitimate authorities persist into later activity?
Option-space	Reachable future possibilities	Which alternatives, exit paths, reversible commitments, or branching possibilities become or remain practically reachable?
Long-horizon	Delayed or cumulative condition	Which returns mature through persistence, maintenance, accumulation, ecological regeneration, or intergenerational transmission?
Uncertain	Return under incomplete knowledge	What return pathways remain plausible, with what evidence, uncertainty, rival explanations, and revision conditions?

competing explanations, intervening conditions, and uncertainty become.

Definition 14.32 (Generative return)**.** Within GRE, a *generative return* is a value-bearing effect attributable, with stated scope and evidential standing, to an earlier generative process and re-entering a later economic process as a materially relevant condition of further generation, maintenance, coordination, adaptation, participation, or transformation. A generative return is indexed to its value form, affected position, re-entry pathway, and time horizon; it need not be financial, accrue to the original contributor, preserve its original value form, or be commensurable with other returns.

Definition 14.32 makes return a relational and historical concept. It concerns a connection between episodes, positions, and conditions rather than a property of an isolated object. A training programme can return capability through later practice; a research process can return epistemic value through reusable knowledge; a cooperative relationship can return relational value through reduced coordination burdens; an institution can return durable procedural capacity; ecological restoration can return material and ecological conditions that later activity depends upon. These examples differ in form and normative significance, yet each can be analyzed through the same recursive question: what generated effect later becomes an input, enabling condition, or stabilizing condition for further activity?

Table 14.13 summarizes the section's analytical architecture.

14.13.1 Immediate Return

Immediate return concerns value-bearing effects that become usable within the active process or its near-term continuation. The word *immediate* is process-relative rather than tied to a universal clock duration. For a digital system, an immediate return may appear within minutes; for a training programme, it may appear within the next task cycle; for infrastructure repair, it may appear when service becomes available again. What matters is that the return becomes practically relevant before a substantial new historical layer separates the source episode from the re-entry episode.

Immediate return should not be identified with immediate output. An output is what an activity directly produces. A return exists when some produced effect re-enters later activity as a useful condition. A workshop can produce a report without producing a return if the report is never used. The same workshop can generate an immediate epistemic return if its findings alter the next design decision, or a relational return if newly established coordination routines improve the next joint task. The recursive link is therefore essential.

Near-term financial receipts are one possible immediate return, but the category is broader. Reduced downtime, newly accessible data, restored mobility, improved coordination, repaired trust, reusable software, or a clarified legal interpretation can all become immediate return when they feed into subsequent action. A narrow financial analysis can remain adequate when the research question concerns cash flow alone. GRE widens the frame when non-financial effects materially alter what later action becomes possible or costly.

Immediate return also needs incidence analysis. The position that experiences a near-term gain need not be the position that generated it. A platform can capture immediate financial return from user-generated data while users receive convenience or network access. A public research project can generate a tool that firms use before the original research organization realizes any direct benefit. A community may bear implementation burdens while a central institution receives administrative learning. The phrase *return to the process* therefore differs from *return to the original contributor*.

This distinction also protects against a common evaluative shortcut. A visible immediate return can coexist with later depletion, lock-in, relational erosion, or ecological cost. Conversely, modest immediate return can accompany substantial long-horizon capability or option-space return. Immediate return is one layer of the return profile, not a privileged proxy for total generative value.

14.13.2 Relational Return

Relational return concerns value-bearing changes in relations that later support coordination, access, reciprocity, trust, legitimacy, care, communication, bargaining, governance, or collective action. Its object is neither an isolated actor nor a generic claim that “relationships matter.” It is a materially relevant relational condition generated through an earlier process and subsequently re-entering economic activity.

A collaboration can generate shared expectations that reduce later coordination burdens. A repeated procurement relationship can generate knowledge of technical

standards and reliable delivery practices. Participatory planning can produce channels through which later problems are identified earlier. Mutual-aid activity can generate trust and reciprocal knowledge that becomes valuable during a later disruption. These effects can persist even after the original transaction or project has ended.

Relational return can be carried by routines, reputation, mutual knowledge, shared language, conflict-resolution practices, or expectations about future conduct. It can also be asymmetric. One position may obtain durable access to another's network or credibility while the reciprocal return remains weak. A broker can become more central through repeated mediation; an organization can accumulate legitimacy from community participation while the community receives little influence over subsequent decisions. Analysis should therefore identify the direction, accessibility, governance, and maintenance burdens of relational return.

Relational return also differs from relation formation itself. A new tie may form without later becoming economically consequential. Conversely, an established relation can generate new return through deepened trust, new shared routines, or expanded coordination capacity. The return concept focuses on the later value-bearing consequences of relational history rather than merely on whether a tie exists.

Maintenance is particularly important. Relational return can dissipate when communication stops, personnel turn over, expectations are violated, or one party repeatedly externalizes maintenance burdens. Durable return may require continued investment in translation, repair, care, governance, or institutional support. A claim about relational return should therefore specify whether the relation has actually become a reusable condition of later action or whether the apparent benefit depends on continuing effort that has been omitted from the account.

Relational return can also be negative or contested in a broader descriptive sense. A relation generated through earlier activity can later support collusion, exclusion, surveillance, clientelism, or dependency. For clarity, GRE reserves the positive evaluative term *return* for effects judged valuable under a stated frame; where the recursive condition is harmful, the analyst should name the generated dependency, extraction pathway, or relational harm directly. This preserves the distinction developed earlier between generativity and value.

14.13.3 Capability Return

Capability return concerns generated abilities that remain available for later action. It includes learned skills, embodied competencies, organizational routines, technical know-how, diagnostic ability, collective coordination capacity, and other effective powers that can be mobilized beyond the episode in which they were formed. Capability return therefore links value generation to the later conversion of capacities into new activity.

Training provides the simplest illustration but does not exhaust the category. A pilot programme can return implementation capacity to an organization. Building an open-source tool can return software-maintenance ability to a community. Responding to a crisis can generate logistical routines that later improve preparedness. A research collaboration can return statistical, experimental, or interpretive capability to participants. These returns may be embodied in individuals, distributed across a

team, stabilized in documentation and infrastructure, or shared across several organizational levels.

The distinction between capability formation and capability return matters. Formation concerns the emergence or strengthening of an ability. Return concerns the later re-entry of that ability into a subsequent process. A course can successfully form a skill that is never used because institutional barriers prevent its exercise. In that case capability formation occurred while capability return remained weak. Conversely, a modest learning episode can generate substantial return if the acquired capacity is repeatedly mobilized across later tasks.

Capability return is therefore conversion-sensitive. Access to equipment, legal permission, organizational authority, time, complementary knowledge, and social recognition can determine whether a capacity becomes practically usable. The same training can produce different return across participants when their conversion conditions differ. Evaluation should avoid attributing weak return solely to the participant when the surrounding architecture blocks realization.

Capability return can also be collective. A team's ability to coordinate complex work is not reducible to the sum of individual competencies. Shared protocols, distributed memory, role differentiation, trust, and communication infrastructure can jointly constitute a collective capability. Turnover can therefore reduce return even when replacement personnel have similar individual credentials, because part of the capability was relational and organizational.

The distribution of capability return can alter later generative opportunity. Positions that repeatedly receive opportunities to learn, experiment, coordinate, and exercise judgment can accumulate capabilities that improve their access to future opportunities. Positions confined to narrow execution roles can receive less return even when they contribute substantially to generation. Capability return is thus relevant to cumulative advantage, justice of participation, and the reproduction of unequal generative capacity.

14.13.4 Epistemic Return

Epistemic return concerns knowledge, evidence, interpretive capacity, memory, models, data infrastructures, uncertainty reduction, and other epistemically relevant effects that later improve inquiry, judgment, or coordinated action. It is broader than information output because a stored dataset, document, or model creates return only when it can be accessed, interpreted, trusted, combined with other evidence, or otherwise used in later processes.

Research activity is an obvious source of epistemic return. Yet operational activity can also generate it. A maintenance programme can reveal recurrent failure modes. A policy pilot can clarify implementation bottlenecks. A community project can generate situated knowledge about access barriers. An institution that documents exceptions and disputes can accumulate interpretive memory that improves later rule application. These forms of return emerge through learning as well as through formal research.

Epistemic return can be embodied, documented, infrastructural, or relational. Em-

bodied return resides in learned judgment. Documented return resides in records, protocols, datasets, or analytical artifacts. Infrastructural return appears in repositories, instrumentation, standards, metadata, or reproducible workflows. Relational return supports epistemic activity through trusted communication channels, recognized expertise, or communities of practice. These forms interact, and loss of one can make another unusable.

Access and provenance are central. Knowledge can be generated collectively while later use is restricted by proprietary control, confidentiality, language, technical format, or institutional status. A public research project can produce substantial epistemic value while the practical return becomes concentrated in organizations that control compute, data integration, licensing, or implementation interfaces. Epistemic-return analysis should therefore identify who can retrieve, understand, validate, modify, and act upon the generated knowledge.

Epistemic return also includes improved awareness of uncertainty. A process can return value by revealing that a previously confident model is unreliable, that an assumed mechanism varies across contexts, or that additional evidence is required. Such return may appear superficially negative because certainty declines. From an epistemic standpoint, better-calibrated uncertainty can improve later judgment and prevent overconfident intervention.

Learning can nevertheless produce misleading apparent return. A post-hoc narrative can attribute later success to an earlier lesson without sufficient evidence. Data generated by an intervention can reflect the intervention's own categories and incentives. A metric can reorganize behavior and then appear to validate the system that created it. Epistemic return should therefore retain the distinction between observation, interpretation, and causal attribution, together with the historical conditions under which the evidence was produced.

14.13.5 Institutional Return

Institutional return concerns generated rules, procedures, rights, organizational capacities, legitimacy, infrastructures, standards, and governance arrangements that persist and later support economically consequential activity. It can arise when an initially local or temporary process leaves behind institutional conditions that make future action more reliable, accessible, coordinated, or contestable.

A pilot programme can generate a durable procurement procedure. A temporary interagency task force can leave a shared data standard. A successful dispute-resolution process can generate precedent, procedural legitimacy, or a reusable forum. Public investment can create administrative routines that improve later delivery. A community organization can generate governance practices that remain useful after the original project ends. These are institutional returns when the generated arrangements subsequently re-enter later processes as enabling or stabilizing conditions.

Institutional return should be distinguished from institutional persistence. A rule can persist while imposing costs, excluding participants, or blocking adaptation. Return requires an explicit evaluative standpoint identifying why the persisted institutional condition is valuable for the relevant process or affected positions. Longevity

alone does not establish institutional value.

Institutional return also has maintenance costs. Procedures need staff, records, training, legitimacy, updating, and sometimes legal authority. Infrastructure needs repair. Standards require coordination. Governance arrangements require participation and conflict resolution. A return claim that counts the durable institution while omitting its maintenance burdens can overstate generative value. Net financial accounting is one way to record some burdens, but relational, epistemic, participatory, and ecological maintenance can remain outside monetary accounts.

Institutional return can alter power. A new certification system can create trust and interoperability while concentrating gatekeeping authority. A data standard can reduce coordination costs while privileging organizations able to comply. A grant programme can strengthen administrative capacity while increasing dependence on the funding institution's categories. Institutional return therefore requires attention to authority, participation, contestability, exit, and control over conversion interfaces.

The possibility of institutional return also helps explain why temporary support can have durable effects. A subsidy, grant, or crisis intervention may end while the procedures, rights, organizations, networks, and legitimacy generated during its operation persist. Conversely, a programme can deliver substantial short-term output while leaving little institutional return if all capability remains external, contracts end abruptly, or local organizations cannot retain the generated routines.

14.13.6 Option-Space Return

Option-space return concerns generated changes that preserve, restore, or expand practically reachable future possibilities. Its object is not the number of abstract alternatives but the structure of later reachability: which actions, relations, technologies, institutional arrangements, locations, or strategies remain feasible, visible, affordable, reversible, and governable for particular positions.

An investment can return option value by creating modular infrastructure that supports several later uses. Training can create occupational mobility. Open standards can reduce switching costs. Ecological restoration can preserve future land-use or livelihood possibilities. Legal recognition can make previously inaccessible institutional pathways reachable. Redundant systems can preserve action during disruption. These returns become economically significant because they change what later actors can still do.

Option-space return differs from immediate flexibility. Some options mature only after complementary capacities or institutions develop. An early research platform can generate later technological branches that were not specified at the time of investment. A public archive can preserve information for questions not yet formulated. Maintaining an ecosystem can preserve biological and economic possibilities whose future use is unknown. The return can therefore consist partly in preserving the conditions under which future discovery remains possible.

This dimension also clarifies the value of reversibility and exit. A process can return value by preserving the capacity to change course after learning. Contractual exit rights, interoperable data, modular infrastructure, diversified suppliers, or re-

versible pilot design can reduce the cost of future revision. Their value may remain invisible if evaluation considers only the path actually chosen rather than the alternatives kept reachable.

Option-space return should not be equated with maximal openness. Some valuable institutions deliberately foreclose harmful, unsafe, or exploitative options. Commitment can also be necessary for long-horizon capacity formation. The evaluative question concerns which possibilities are preserved or removed, for whom, under what justification, and with what consequences for later generative capacity. Option-space return is therefore indexed to both reachability and the value assigned to the preserved possibilities.

Because option spaces are only partly observable, measurement is difficult. Analysts can often observe exercised options more easily than preserved but unused possibilities. Proxies such as interoperability, diversity, spare capacity, rights of exit, modularity, institutional revisability, and ecological resilience may provide evidence, but they should remain explicitly linked to the mechanism through which they are expected to preserve practical reachability.

14.13.7 Long-Horizon Return

Long-horizon return concerns value-bearing effects whose economically material reentry occurs after substantial temporal separation from the originating process. The separation can involve delayed maturation, cumulative learning, infrastructure life cycles, institutional persistence, ecological regeneration, demographic change, or intergenerational transmission. Long-horizon return therefore makes historical attribution and maintenance especially important.

Many generative processes have temporal profiles that differ sharply from financial reporting periods. Education can return capability over decades. Preventive health measures can preserve future participation. Research infrastructure can support unanticipated discoveries. Institutional reform can alter expectations slowly through repeated application. Ecological restoration can require long biological timescales before material or livelihood effects become visible. A short evaluation horizon can systematically undervalue such processes.

Temporal extension does not guarantee positive return. Infrastructure can become obsolete, institutions can ossify, knowledge can lose relevance, and ecological interventions can have unintended consequences. Long-horizon analysis should therefore track survival, adaptation, conversion, and maintenance rather than extrapolating early benefits indefinitely. The persistence of a generated condition is an empirical and historical question.

Long-horizon return can also cross generations. Education, public infrastructure, legal institutions, ecological conditions, debt structures, scientific knowledge, and technological standards can alter the starting conditions inherited by later cohorts. The beneficiaries, contributors, and burden bearers may therefore be separated in time. Intergenerational return analysis should preserve this distribution rather than treating society as a single timeless recipient.

Discounting provides one possible financial or decision-analytic representation of

delayed effects, but GRE does not assume that every long-horizon value form can be adequately reduced to a discounted monetary scalar. Capability, ecological integrity, institutional legitimacy, irreversible harm, and option preservation can require additional representation. Monetary discounting can remain useful within a stated protocol; it should not silently decide the relative normative significance of heterogeneous future values.

Long-horizon return also raises responsibility for maintenance. A durable asset can generate little return if future actors lack resources to maintain it. Knowledge can disappear when archives fail. Institutional capacity can decay when training and succession are neglected. Ecological gains can reverse under later pressure. Return therefore depends partly on the future conditions required to preserve or regenerate the generated value-bearing effect.

14.13.8 Return under Uncertainty

Generative return is frequently uncertain because future states, conversion conditions, institutional responses, technological change, ecological dynamics, and downstream uses cannot be known completely at the time of generation. Uncertainty affects both whether a return will appear and what form it will take. The analytical task is therefore to represent plausible return pathways and their evidential standing without converting every unknown into a precise probability or collapsing heterogeneous returns into a common expected-value metric.

Several uncertainties can be distinguished. *Realization uncertainty* concerns whether the generated effect will become usable later. *Timing uncertainty* concerns when re-entry will occur. *form uncertainty* concerns which value form will become salient: a research process can return financial value, capability, knowledge, institutional legitimacy, or an unforeseen combination. *incidence uncertainty* concerns who will receive, control, or bear the consequences. *attribution uncertainty* concerns how strongly the later condition can be linked to the earlier process. *evaluation uncertainty* concerns whether later actors will judge the resulting condition as valuable under changed circumstances.

Uncertainty should therefore be associated with the return pathway rather than appended as a generic caveat. A claim about long-horizon ecological return may have strong mechanism evidence but uncertain magnitude. A claim about future commercial return may have a wide range of plausible values and substantial market uncertainty. A claim about institutional return may have clear near-term evidence but uncertain durability. Different uncertainty structures call for different representations.

Scenario analysis can be useful when several coherent future configurations matter. Sensitivity analysis can test dependence on key assumptions. Probability distributions can be appropriate when a defensible statistical model exists. Qualitative uncertainty descriptions can be more adequate when probabilities would create false precision. Partial ordering can compare strategies that dominate under several plausible futures without assigning a common cardinal value to every return. The method should follow the evidence and decision problem.

Return under uncertainty also gives analytical value to option preservation, re-

versibility, diversification, and staged commitment. A process can be valuable partly because it generates information while preserving the ability to revise later action. In such cases, the return includes learning and maintained reachability rather than only the final material output. This connects generative return to adaptive allocation and to the option-space analysis developed earlier in the book.

Attribution becomes particularly difficult when many actors and histories contribute to a later return. Scientific knowledge can rest on cumulative public investment, prior research, infrastructure, education, and international collaboration. Institutional legitimacy can emerge from repeated interactions across many episodes. Ecological recovery can depend on several interventions plus favorable external conditions. A provenance-sensitive analysis should therefore permit distributed contribution and avoid assigning exclusive causal ownership merely because one actor can identify a visible final step.

The same discipline applies to failure. Absence of an expected return does not by itself prove that the originating process had no generative value. A capacity may have formed but encountered a later institutional barrier; ecological return may have been offset by an external shock; generated knowledge may remain unused because access is restricted. Evaluation should distinguish failure of generation, failure of transmission, failure of conversion, capture, dissipation, and adverse later conditions.

Proposition 14.33 summarizes the section's analytical requirement.

Proposition 14.33 (Provenance and horizon of generative return)**.** *Within GRE, a claim of generative return is adequately specified when it identifies, at the level required by the inquiry, the originating generative process, the returned value-bearing condition, the affected position or positions, the re-entry pathway into later activity, and the relevant time horizon, while preserving material uncertainty and alternative explanations. A return claim does not by itself establish financial profitability, conservation of value, exclusive causal ownership, commensurability among heterogeneous returns, or overall normative desirability.*

Proposition 14.33 makes generative return a historically reconstructable relation rather than a retrospective label attached to favorable outcomes. Immediate, relational, capability, epistemic, institutional, option-space, and long-horizon returns can coexist and can accrue to different positions through different pathways. Their analysis therefore requires provenance without demanding a universal return metric. This architecture also prepares the next section's historical question: how scarcity, productive forces, institutions, subject positions, value forms, and valuation practices can change over time, thereby altering both the value generated in an earlier period and the meaning assigned to its later return.

14.14 Historical Transformation of Value

This section develops the historical transformation of value as a distinct problem within GRE. Its role is to explain how value-bearing conditions, value forms, valuation practices, and the epistemic means through which value is recognized can change across time. The objective is to distinguish transformation in what is materially, relationally, institutionally, or practically valuable from transformation in the categories,

symbols, measures, and evaluative conventions through which value becomes visible. The discussion proceeds through changing scarcity, productive forces, institutions, subject positions, value forms, valuation practices, and re-epistemization of value. The method is historical and relational: each transformation is indexed to a period, configuration, affected position, value form, and evidential standpoint rather than represented as movement along a timeless value scale.

Historical analysis matters because value concepts can become misleading when the background conditions that gave them meaning are treated as fixed. A resource scarce under one technological and institutional configuration can become abundant under another. A skill can lose exchange value while retaining capability or cultural value. A legal entitlement can acquire practical value when enforcement improves, or lose practical value while remaining formally unchanged. Knowledge once difficult to obtain can become inexpensive to reproduce while the capacity to interpret, validate, or act upon it becomes more valuable. Environmental conditions once treated as background can become economically salient when ecological degradation makes their regenerative functions visible. The relevant change can occur in the valued condition, in the relation through which it is realized, in the evaluative standpoint, or in the epistemic apparatus through which it is recognized.

Historical political economy provides important precedents for this orientation. Marx links changes in productive forces and relations of production to historically specific economic forms, while Polanyi analyzes the institutional reorganization of economic life associated with market society (Marx 1859; Marx 1867; Polanyi 1944; Polanyi 1957). GRE does not adopt either framework as a complete historical theory of value. It draws a narrower methodological implication: economic value is often conditioned by historically variable productive, institutional, and relational arrangements. Evolutionary economics similarly emphasizes that routines, innovation, selection, and cumulative change alter the environment in which economic action takes place (Nelson and Winter 1982). These traditions differ substantially, yet each resists a purely static representation of economic significance.

The historical problem also extends to valuation itself. Appadurai's account of commodity trajectories emphasizes that commodity status and value can vary across social contexts and histories (Appadurai 1986). Dewey treats valuation as situated activity involving ends, appraisal, and consequences rather than passive discovery of a fixed property (Dewey 1939). Sociological studies of valuation and commensuration likewise show that evaluative categories, metrics, and monetary representations are institutionally organized and can feed back into the practices they describe (Lamont 2012; Espeland and Stevens 1998; Fourcade 2011). GRE therefore distinguishes historical transformation of value from historical transformation of valuation while allowing the two to interact.

Definition 14.34 (Historical transformation of value)**.** Within GRE, a *historical transformation of value* is a temporally situated change in the realization, distribution, form, evaluative significance, or generative consequences of a value-bearing condition produced through materially relevant changes in productive, relational, institutional, ecological, epistemic, symbolic, or subject-position conditions. The concept does not require a universal value metric and does not imply that every change in valuation corresponds to an equivalent change in the underlying value-bearing con-

Table 14.14: Analytical dimensions of historical transformation of value in GRE

Historical dimension	**Primary transformation**	**Diagnostic question**
Scarcity	Relative availability and access	Which material, institutional, relational, or positional conditions make a value-bearing object or capacity scarce for whom?
Productive forces	Capacity to produce, reproduce, and transform	How do technology, skills, infrastructure, organization, energy, and knowledge alter what can be generated and at what cost?
Institutions	Rules, rights, classifications, and enforcement	Which institutional changes alter access, convertibility, legitimacy, risk, or the realization of value?
Subject positions	Situated capacities and relations	How does the same condition acquire different significance for differently positioned subjects and collectives?
Value forms	Modes through which significance is realized	Which value forms become newly salient, decline, combine, or emerge under changing historical configurations?
Valuation	Practices of appraisal and comparison	Which categories, metrics, prices, narratives, and procedures reorganize what becomes visible or actionable as value?
Re-epistemization	Revision of what can be known about value	Which new evidence, concepts, models, experiences, or affected voices change the epistemic standing of earlier value judgments?

dition.

Definition 14.34 makes two forms of historical change analytically separable. The first concerns a change in the conditions through which value is generated or realized. The second concerns a change in how that value is recognized, categorized, represented, or judged. They can coincide. A new institution can make a previously inaccessible capability realizable while simultaneously creating a metric that records it. They can also diverge. An accounting reform can change reported value without changing the material or relational condition being represented, while an ecological decline can substantially alter future value before conventional accounts register the change.

Table 14.14 summarizes the section's analytical architecture.

14.14.1 Changing Scarcity

Scarcity is historically variable because availability is produced through more than physical quantity. Technology, infrastructure, law, market organization, ecological conditions, political borders, standards, distribution systems, social position, and institutional access all influence whether a resource or capability is practically scarce. GRE therefore treats scarcity as a relation among available conditions, demand or need, conversion capacities, access rules, and historically situated positions rather than as an intrinsic property of an object alone.

A material can become less scarce when extraction or production technology changes, while complementary conditions become more scarce. Cheap computation

can increase the availability of processing capacity while making high-quality data, electrical power, specialized chips, cooling infrastructure, or expert interpretation more consequential bottlenecks. Digital reproduction can make information inexpensive to copy while increasing the value of trusted provenance, attention, verification, or institutional recognition. Expanded transportation can reduce geographic scarcity for some goods while increasing dependence on logistics infrastructure or energy systems. Historical scarcity therefore often moves rather than simply disappears.

The relevant unit of analysis also matters. A good can be abundant at aggregate scale and scarce for a particular household, region, institution, or subject position. Food can be plentiful nationally while inaccessible locally because purchasing power, mobility, legal status, or distribution infrastructure is constrained. Knowledge can be publicly available while practically inaccessible because language, education, institutional credentials, or technical infrastructure limit use. Ecological conditions can remain physically present while becoming functionally scarce because quality has deteriorated. A historically adequate scarcity claim should therefore state whose scarcity is being analyzed and through which access or conversion mechanism.

Changing scarcity can transform value in several ways. Exchange value can change when supply-demand relations shift. Capability value can change when a previously rare enabling condition becomes widely accessible. Relational value can increase when trustworthy coordination becomes difficult in a fragmented institutional environment. Option value can rise when uncertainty makes reversible alternatives scarce. Ecological value can become more salient when regenerative capacities approach stress or depletion. None of these changes requires a universal scarcity-value law. The point is narrower: scarcity conditions participate in how particular value forms become realized and prioritized.

Historical comparison also requires caution about retrospective projection. A resource that appears obviously valuable under present conditions may not have occupied the same role in an earlier configuration. Conversely, an older practice can have possessed substantial capability, institutional, or ecological value even when it was weakly represented in monetary accounts. Historical analysis should therefore reconstruct the scarcity structure relevant to the period being studied rather than importing current prices, technologies, infrastructures, or evaluative categories without adjustment.

14.14.2 Changing Productive Forces

Changes in productive forces alter what an economy can produce, reproduce, maintain, and transform. The term is used here in a broad analytical sense encompassing technology, embodied skill, scientific and practical knowledge, organizational routines, infrastructure, energy systems, tools, compute, ecological inputs, and the coordinated capacities through which production becomes possible. Marx's historical analysis gives productive forces a central role in transformations of economic organization (Marx 1859; Marx 1867). GRE uses the category more modestly as one dimension of historical change rather than as a complete theory of historical development.

A change in productive capability can alter value without changing the physical identity of the output. Automation can reduce the labor time required for one task

while increasing the value of design, maintenance, integration, judgment, or complementary human capabilities. New infrastructure can make remote resources usable, thereby altering both material value and spatial option structures. Scientific knowledge can transform a previously unusable material into an input, or reveal a previously ignored external cost. Organizational innovation can make distributed cooperation feasible where prior coordination costs prevented it. Productive change therefore affects both what can be produced and which complementary relations or capacities become consequential.

The transformation is often asymmetric. A technology can expand aggregate productive capacity while devaluing some existing skills, increasing the importance of others, and shifting bargaining power among positions. A platform can reduce transaction costs while concentrating control over standards or access. A new energy system can lower one environmental burden while creating new material dependencies. Productive forces therefore have distributive and relational incidence. Historical transformation of value cannot be inferred from aggregate productivity alone.

Productive change can also generate new value forms. Large-scale digital systems have made data, interoperability, software maintenance, model reliability, cybersecurity, and compute access economically salient in ways that differ from older industrial configurations. These developments do not make earlier value forms obsolete. Material, financial, capability, relational, institutional, and ecological value remain relevant, but their interdependence and relative visibility can change. A historical account should therefore track both continuity and transformation rather than narrate value history as a succession in which each new form replaces the previous one.

The same discipline applies to generative value. A productive innovation can increase present output while narrowing future options through lock-in, ecological depletion, skill erosion, or institutional dependency. Another innovation can initially appear inefficient while creating knowledge, infrastructure, or capabilities that increase later generative opportunity. Historical evaluation therefore needs a horizon long enough to identify how productive change modifies the conditions of subsequent generation.

14.14.3 Changing Institutions

Institutions shape value by organizing rights, obligations, classifications, enforcement, access, eligibility, authority, and legitimate forms of transaction. Institutional change can therefore alter value even when the underlying material object remains unchanged. A plot of land acquires different practical significance under different property, zoning, inheritance, taxation, or environmental regimes. Knowledge has different economic realization conditions under different intellectual-property, publication, licensing, and professional systems. A skill can become more valuable when certification grants access to a protected occupation, or less valuable when institutional recognition changes.

Polanyi's treatment of the economy as an instituted process provides a useful precedent for examining how exchange, redistribution, reciprocity, and other patterns are socially organized (Polanyi 1957). North likewise emphasizes the role of institutions in structuring interaction and long-run economic change (North 1990). GRE does not

infer that institutions determine value unilaterally. Material properties, productive conditions, preferences, ecological constraints, and relational histories continue to matter. Institutional analysis asks how rules and recognized categories condition their realization.

Institutional transformation can create value by enabling coordination, reducing uncertainty, protecting rights, stabilizing expectations, or making collective capacities durable. It can also destroy or redistribute value by excluding positions, invalidating credentials, weakening public provision, changing liabilities, or reallocating control over conversion interfaces. The same institutional reform can therefore generate institutional value for one set of positions while producing capability loss or dependency for another.

Historical institutional change also affects what counts as an economically legible object. Accounting rules can make some assets visible while leaving relational or ecological conditions outside the balance sheet. Legal reforms can recognize previously informal claims. Statistical systems can create categories that organize public attention and resource allocation. Markets can emerge where exchange had previously been restricted or socially disfavored. These changes demonstrate why manifestation and measurement should be distinguished from underlying value-bearing conditions: institutional recognition can make value newly actionable without implying that the relevant condition came into existence at the moment of recognition.

Institutional histories are often path dependent. Earlier classifications, infrastructures, contracts, and standards can shape the cost of later revision. Yet path dependence does not imply inevitability. Institutional reinterpretation, political contestation, technological change, legal reform, collective learning, and external shocks can reopen previously stabilized arrangements. Historical value analysis should therefore identify both inherited constraints and mechanisms through which institutional value structures become revisable.

14.14.4 Changing Subject Positions

Value is also historically transformed when subject positions change. A subject position is the historically situated location from which a person, household, organization, community, or other actor can access resources, exercise rights, participate in institutions, bear risks, maintain relations, or convert available conditions into effective capabilities. The concept does not reduce subjects to structural positions; it identifies one layer through which the same object or institution can have different practical significance for differently situated actors.

Subject positions change through education, employment, migration, legal status, technological adoption, household composition, organizational role, wealth, social networks, health, political recognition, and many other processes. The same information can have high epistemic value for a trained specialist and little immediate value for a person lacking the tools needed to interpret it. A flexible work arrangement can increase option value for one household while shifting care burdens onto another. A digital service can expand capability for a connected user while creating exclusion for a person lacking identity documentation, devices, reliable connectivity, or accessible interfaces.

Historical transformation of subject position can therefore change value without any modification to the nominal resource. Sen's capability tradition is relevant because it distinguishes resources from the substantive freedoms people can realize with them (Sen 1985; Sen 1999). GRE extends this insight historically and relationally: conversion conditions themselves can change over time, and they can be generated through institutions, relations, infrastructures, and prior allocations. Value realized by a subject today may therefore depend on a long historical trajectory of capacity formation and access.

Subject positions are also relational. Workers, employers, creditors, debtors, patients, caregivers, platform operators, users, citizens, migrants, experts, and clients occupy positions partly constituted through relations with others and with institutions. A change in one position can alter the value available to another. Greater bargaining alternatives can increase the value of exit; professional monopolies can raise institutional value for credential holders; expanded public provision can reduce dependency on employers or households. Historical value transformation is therefore often positional and relational rather than purely individual.

The evaluative implication is significant. Historical comparisons that use one representative subject can obscure changes in incidence. An institution may become more efficient while shifting maintenance burdens to households. A technology may become cheaper while imposing new learning costs on older users. A new market may increase aggregate exchange while weakening forms of community reciprocity valued by some participants. A historical account should therefore state whose subject position has changed and which value forms become more or less realizable as a result.

14.14.5 Changing Value Forms

The forms through which value is realized and recognized can themselves change historically. Section 14.2 distinguished material, financial, capability, relational, epistemic, institutional, participatory, option, future, and ecological value as overlapping analytical forms. That taxonomy is intended as a working architecture rather than a timeless inventory. Historical change can increase the salience of one form, generate new combinations among forms, or make previously weakly articulated value economically consequential.

Commodity status provides a useful example. Appadurai emphasizes that things can move into and out of commodity situations across their social trajectories (Appadurai 1986). GRE generalizes the underlying historical point: value forms can be activated, suppressed, translated, or reorganized as institutional and relational conditions change. A household object can become a collectible; a public dataset can become a commercial input; a local ecological condition can become recognized as critical infrastructure; an informal skill can become a certified professional capability. The object need not remain evaluatively identical across these transitions.

Changing value forms should not be mistaken for simple relabeling. When a new form becomes economically operative, it can alter rights, incentives, access, measurement, and conversion possibilities. Treating a relationship as a contractual asset can change how it is governed. Treating biodiversity as an ecosystem service can make

ecological processes visible to policy while also encouraging particular forms of commensuration. Treating data as an asset can support investment while changing control over epistemic and relational resources. Value-form transformation can therefore have performative effects.

At the same time, newly visible forms need not displace older ones. Financialization can increase the importance of financial representations without eliminating material, capability, relational, or ecological significance. Digitalization can increase epistemic and option value while remaining dependent on physical infrastructure, energy, labor, and institutional systems. Historical value analysis should therefore allow layered forms and hybridization rather than impose a sequence in which economies progress from one dominant value form to another.

This historical openness also matters for GRE itself. The forms identified in the present chapter are provisional analytical categories. Future economic configurations may make distinctions visible that the present framework represents poorly. A research programme that treats its taxonomy as historically revisable is better able to recognize emergent forms without forcing them prematurely into inherited categories.

14.14.6 Changing Valuation

Valuation practices change historically even when the underlying value-bearing condition changes little. New prices, accounting conventions, rankings, certifications, indicators, legal damages, cost-benefit procedures, scoring systems, and public narratives can reorganize how an object or process is judged. Dewey's theory of valuation emphasizes appraisal as situated activity, while sociological work studies valuation and evaluation as socially organized practices (Dewey 1939; Lamont 2012). GRE uses these insights to treat valuation as an economic process with its own history.

Changing valuation can affect what becomes visible. Environmental damage can move from an unpriced external condition to a legally recognized liability or monetary estimate. Care work can move from taken-for-granted household activity to an object of labor statistics and policy analysis. Educational credentials can acquire stronger screening value even when the underlying skills they represent change less. Rankings can transform reputational hierarchies by making organizations responsive to measured criteria. Such changes alter the manifestation and institutional actionability of value.

Valuation can also feed back into the valued process. Espeland and Stevens show that commensuration changes cognition and social relations, while Fourcade demonstrates that monetary valuation of nature depends on institutionalized techniques and can reshape social understandings of the valued object (Espeland and Stevens 1998; Fourcade 2011). A historical change in valuation is therefore not merely a change in description. Once attached to budgets, eligibility, compensation, investment, or status, evaluative representations can redirect behavior and alter future value-generation pathways.

This performativity creates a diagnostic challenge. An increase in a measured value can arise because the underlying condition improved, because the metric changed, because actors adapted to the metric, because the institutional boundary

moved, or because the evaluative standpoint changed. Historical analysis should therefore preserve measurement provenance and distinguish change in the represented world from change in the representation system. Section 14.12 developed this distinction for measurement; the historical problem is to reconstruct when and why the representational system itself changed.

Valuation histories also reveal conflicts among value orders. A practice can shift from being judged through professional norms to financial metrics, from local custom to standardized regulation, or from ecological stewardship to asset valuation. Such transitions may improve comparability or accountability while losing context-specific information. The analytical task is not to assume that older or newer valuation regimes are superior. It is to identify what each regime makes visible, what it compresses, who gains evaluative authority, and how the shift changes practical economic consequences.

14.14.7 Re-Epistemization of Value

Historical transformation also occurs through *re-epistemization*: revision of what can be known, credibly claimed, or responsibly inferred about value. Re-epistemization can follow new evidence, new concepts, improved measurement, changes in affected-subject testimony, scientific discovery, institutional learning, historical reinterpretation, or recognition that an earlier representation systematically omitted relevant conditions. It concerns the epistemic status of a value claim rather than automatically implying that the underlying world changed at the same moment.

Definition 14.35 (Re-epistemization of value)**.** Within GRE, *re-epistemization of value* is a historically situated revision of the evidence, concepts, categories, models, standpoints, or interpretive procedures through which a value-bearing condition is identified, attributed, compared, or evaluated. Re-epistemization can revise a prior value judgment without implying that the relevant material, relational, institutional, or ecological condition changed simultaneously.

Definition 14.35 distinguishes epistemic revision from ontological replacement. A pollutant can have imposed ecological and health burdens before scientific evidence established the mechanism. Unpaid care can have sustained economic reproduction before national accounts or labor statistics represented it. A community can have experienced institutional harm before administrative categories made that harm legible. Later knowledge can therefore revise evaluation of earlier events without pretending that the later knowledge was available to earlier decision makers.

Re-epistemization can also lower earlier estimates of value. Technologies once expected to generate large long-horizon returns can prove less durable than anticipated. Institutions considered stable can be shown to have excluded significant populations. A celebrated productivity gain can be reinterpreted after maintenance costs or ecological burdens become visible. Historical evaluation should permit such revision while preserving the epistemic conditions of the earlier judgment. Otherwise retrospective analysis risks collapsing uncertainty into hindsight.

The sources of re-epistemization are plural. Scientific evidence can reveal causal mechanisms; qualitative inquiry can uncover lived consequences that aggregate indicators miss; historical archives can reconstruct prior institutional arrangements;

new measurement can expose distributional patterns; affected communities can contest categories imposed upon them; formal models can identify overlooked dependencies; and comparative cases can show that arrangements once regarded as necessary were contingent. No single method has automatic priority. The appropriate epistemic route depends on the value claim and the phenomenon under study.

Re-epistemization can itself redistribute value and power. A new classification can change eligibility for compensation. Recognition of previously ignored expertise can alter institutional authority. Revised ecological knowledge can change land-use restrictions or asset values. New evidence about discrimination can transform the value of procedural reforms. Epistemic events therefore participate in economic history rather than merely documenting it.

The historical architecture developed in this section can be summarized as a distinction among three interacting processes: transformation of value-bearing conditions, transformation of valuation practices, and transformation of knowledge about value. They often co-evolve. Productive change can create new scarcity; institutions can make new value forms operable; valuation systems can redirect behavior; new evidence can revise institutional rules; and revised institutions can generate new forms of data and experience. Historical analysis becomes misleading when these layers are collapsed into one undifferentiated change in "value."

Proposition 14.36 states the resulting scope condition.

Proposition 14.36 (Historical differentiation of value transformation)**.** *Within GRE, an adequate historical claim about transformation of value should distinguish, at the level required by the inquiry, changes in value-bearing conditions from changes in subject position, value form, valuation practice, measurement representation, and epistemic standing. These dimensions may interact and co-evolve, but change in one does not by itself establish equivalent change in the others. Historical comparison should therefore preserve period-specific conditions, affected positions, evaluative standpoints, and evidential provenance rather than projecting a current value representation backward as a timeless metric.*

Proposition 14.36 keeps historical transformation compatible with the chapter's plural-value architecture. Value can change because the world changes, because relations and institutions change, because subjects become differently positioned, because new value forms become operative, because valuation practices change, or because knowledge about earlier conditions is revised. The distinctions are analytical rather than claims that these processes occur independently. Their purpose is to make historical reasoning more precise. They also prepare the chapter's next problem: how value processes are organized across multiple temporal scales, including fast and slow dynamics, delayed realization, persistence, and intergenerational horizons.

14.15 Value Processes in Generative Spacetime

This section closes Chapter 14 by integrating its plural account of value with the temporal, spatial, relational, and historical organization of economic processes. Its role is to show why value generation, transmission, conversion, recirculation, accumula-

tion, dissipation, harm, valuation, and return cannot always be analyzed adequately as properties of isolated states. The objective is to specify a process-oriented interface through which these value phenomena can be represented as trajectories distributed across events, relations, positions, scales, and historical horizons. The discussion proceeds through value as process, value trajectories, delayed generation, historical dependence, propagation, recirculation, and a bounded introduction to generative spacetime. The method is synthetic rather than foundational: it draws together distinctions already established in this chapter while preserving ontological suspension and postponing the fuller event, accessibility, distance, sequence, and trajectory formalism to Chapter 15.

The chapter has progressively displaced the idea that economic value can be represented adequately by one static object, one price, one owner, one moment, or one metric. Sections 14.4–14.14 developed generation, transmission, conversion, recirculation, accumulation, dissipation, harm, plurality, measurement, return, and historical transformation as differentiated processes. Taken together, these analyses imply a further methodological point: the significance of a value-bearing condition often depends on *where it occurs in a history*, which relations connect it to earlier and later events, which positions can access it, how long realization takes, which scales mediate its propagation, and which later possibilities it opens or closes.

This temporal-spatial orientation should not be read as a claim that economic value literally occupies a physical spacetime in the same sense as a physical field or particle. GRE uses spacetime language as an analytical resource for representing ordered events, historical depth, relational distance, reachability, delay, scale, and changing possibility structures. Physical analogies can be useful when their structural content is made explicit, while the social, institutional, ecological, epistemic, and normative meanings of economic processes remain irreducible to those analogies. The present section therefore establishes an interface rather than a final ontology.

Table 14.15 summarizes the section's main dimensions.

14.15.1 Value as Process

A process-oriented account of value begins from the observation that many economically significant conditions become intelligible only through their history of generation, transformation, use, maintenance, and consequence. A skill is not exhausted by the moment it is certified; its value can depend on earlier learning, present opportunities for exercise, complementary tools, institutional recognition, and later adaptation. A relation is not exhausted by the existence of a tie; its value can depend on how trust was formed, which obligations have accumulated, whether coordination remains reliable, and how the relation changes when participants or institutions change. Infrastructure similarly derives significance from construction, maintenance, accessibility, interoperability, deterioration, and the future processes it enables.

The phrase *value as process* does not imply that every value attribution should be replaced by a process description. Prices, balances, stocks, ownership states, capability profiles, institutional statuses, and measured outcomes can remain appropriate representations for many questions. The process perspective becomes important when the path connecting such states materially affects interpretation. A current

Table 14.15: Spatiotemporal dimensions of value-process analysis in GRE

Dimension	**Primary analytical object**	**Diagnostic question**
Process	Ordered or partially ordered transformation	Through which events and relations is a value-bearing condition generated, transformed, realized, or diminished?
Trajectory	Historically situated path or branching path	Which positions, value forms, interfaces, and scales does the process traverse, and what provenance is preserved?
Delay	Latency between contributing conditions and realization	When does a generative contribution become effective, observable, or evaluable, and which intervening conditions matter?
Historical dependence	Dependence on inherited sequence and configuration	Which prior events, institutions, capacities, or path-specific constraints condition present value realization?
Propagation	Extension across relations, positions, space, or scale	How far, through which channels, and with what attenuation, amplification, transformation, or exclusion do effects travel?
Recirculation	Re-entry into later generative processes	What returns, in which form, to which positions, and how does re-entry alter the conditions of the next cycle?
Generative spacetime	Joint organization of event order, reachability, distance, scale, and possible continuation	Which value-process distinctions require a richer historical and relational representation than a sequence of static states?

stock of financial resources may have different implications depending on whether it arose through productive return, debt, extraction, inheritance, public transfer, or temporary liquidation. Two institutions with similar present budgets may possess very different relational histories, maintenance burdens, legitimacy, knowledge infrastructures, and future option structures.

Process analysis therefore adds historical and relational provenance to state description. It asks how a value-bearing condition came to occupy its current position, what transformations it underwent, what burdens were displaced or accumulated, and how it participates in later generation. This perspective is compatible with the chapter's ontological restraint. Describing value through processes does not establish that value is ultimately nothing other than process. It establishes only that processual information can be analytically necessary for certain economic questions.

A value process can include several of the operations developed earlier in the chapter. Generation can produce a capability; transmission can carry its effects across positions; conversion can transform epistemic value into institutional recognition; recirculation can return the resulting capacity to later practice; accumulation can stabilize or concentrate it; dissipation can weaken its practical availability; and re-epistemization can alter how the history itself is understood. These operations need not occur in a fixed order, and several can occur simultaneously. The analytical task is to preserve the distinctions that matter to the case rather than to force all value processes into one canonical cycle.

This process orientation also changes how endpoints are interpreted. An observed

endpoint may summarize a long history while concealing the distribution of contributions, constraints, delays, and harms through which it was produced. A profitable organization, a high-performing school, a productive research system, or a resilient community can embody accumulated contributions from actors who no longer occupy visible positions in the current state. Historical reconstruction is therefore relevant not only to explanation but also to questions of attribution, return, responsibility, and justice.

14.15.2 Value Trajectories

A trajectory representation makes process history more explicit. Within GRE, a value trajectory records a historically ordered pattern through which a value-bearing condition, or the effects associated with it, passes across positions, relations, interfaces, value forms, scales, or evaluative horizons. A trajectory can be linear in a simple case, but more complex value histories can branch, merge, recur, terminate, or remain only partially ordered.

Definition 14.37 (Value-process trajectory)**.** Within GRE, a *value-process trajectory* is a bounded analytical representation of the historically ordered or partially ordered events, relations, positions, value forms, interfaces, and scale transitions through which a value-bearing condition is generated, manifested, transmitted, converted, recirculated, accumulated, diminished, evaluated, or returned. A trajectory preserves only the distinctions required by the inquiry and does not imply conservation of a homogeneous substance, deterministic succession, or a unique complete history.

Definition 14.37 treats trajectories as representations rather than as pre-given objects. The analyst chooses a boundary and a level of resolution. A study of a grant may trace financial resources into equipment, equipment into research capability, research into knowledge, knowledge into institutional recognition, and later recognition into new funding. A study of care may trace time, skill, trust, health, household capacity, and later labor-market or community participation. A study of ecological restoration may trace material interventions, ecological regeneration, institutional maintenance, and later livelihood or risk-reduction effects. Different inquiries can construct different trajectories from the same broader history.

Trajectory language also clarifies why value transmission is not equivalent to movement of a conserved quantity. A source condition can be transformed as effects pass through an interface; several recipient positions can benefit without a corresponding subtraction from the source; one value form can support another without a meaningful common unit; and some effects can dissipate while others amplify. The trajectory therefore carries provenance and transformation history rather than presuming a conserved flow.

Branching is especially important. A generated capability can support several later projects; a new institutional rule can alter many subsequent decisions; an infrastructure investment can create multiple access pathways; a harmful constraint can foreclose several alternatives at once. Conversely, several earlier trajectories can converge in one later outcome. A scientific discovery may depend on education, public infrastructure, prior research, organizational coordination, and technological tools generated at different times and places. A single-chain causal story can therefore

underrepresent the distributed historical architecture of value.

Trajectory comparison should also preserve scale. Similar local trajectories can produce different system-level consequences when they occur within different institutional or spatial configurations. Conversely, a system-level pattern can contain sharply heterogeneous local trajectories. GRE therefore treats the trajectory boundary, the represented positions, and the scale of comparison as explicit analytical choices. Chapter 15 will develop these trajectory problems more systematically through event, ordering, and multiscale representations.

14.15.3 Delayed Generation

Value generation frequently contains delay between contributing conditions and later realization. Education, scientific research, infrastructure, ecological restoration, institutional reform, trust building, preventive maintenance, and capability formation can generate effects whose practical significance becomes visible only after additional events occur. Delayed generation therefore requires more than attaching a discount factor to an otherwise immediate outcome. It requires analysis of latency, enabling conditions, thresholds, intervening processes, and the difference between generation and observation.

Three temporal distinctions are useful. First, a value-bearing condition can be *generated earlier but realized later*. Knowledge may exist before an institution can apply it. A capability may be acquired before an opportunity to exercise it appears. Second, the relevant condition can be *generated only through later interaction*. An initial intervention may create one necessary element, while the valued outcome appears only after complementary infrastructure, institutional authorization, or collective participation develops. Third, an effect can be *realized earlier but observed later*. Harm, ecological depletion, or institutional erosion can precede the evidence through which analysts eventually recognize it.

These distinctions constrain causal attribution. Temporal distance alone neither proves nor defeats a connection between an earlier process and a later value-bearing effect. A plausible account needs a mechanism, preserved trace, comparison, process evidence, or another evidential basis adequate to the claim. As the time horizon lengthens, competing explanations and intervening conditions generally become more important. Long-horizon generative-return claims should therefore preserve uncertainty rather than retrospectively treating the observed outcome as inevitable.

Delay also affects institutional evaluation. Short budget cycles can undervalue processes whose returns mature slowly, while long commitments can preserve ineffective arrangements when delayed benefits are assumed rather than evidenced. A process-sensitive evaluation therefore asks which forms of delay are expected, what intermediate indicators are meaningful, which maintenance conditions are required, and when revision becomes appropriate. The aim is neither to privilege short-term observability nor to protect long-horizon projects from scrutiny.

Delayed generation can also interact with distribution. One group may bear costs now while another receives benefits later; present participants may create capabilities used by future participants; one region can supply ecological or infrastructural conditions whose return appears elsewhere. Intergenerational and cross-scale delay

therefore connects temporal structure to incidence and justice. Chapter 15 will develop delayed and latent generation as a dedicated spacetime problem; the present chapter establishes why value analysis needs that extension.

14.15.4 Historical Dependence

Value processes are historically dependent when earlier events or configurations materially condition the significance, accessibility, or generative effect of later ones. Section 14.14 showed that scarcity, productive forces, institutions, subject positions, value forms, valuation, and epistemic standing can all change historically. The present subsection adds a trajectory-level implication: a later value-bearing condition can depend on the sequence through which those changes occurred, not only on the variables visible at the endpoint.

Historical dependence can arise through several mechanisms. Learning can accumulate tacit knowledge that cannot be reconstructed instantly from current documentation. Infrastructure can create complementarities that make later technologies more or less viable. Legal rules can stabilize expectations and property relations that shape subsequent investment. Repeated cooperation can build trust or dependency. Early standards can coordinate future systems around particular interfaces. Ecological depletion can narrow later productive options. Each mechanism carries a history that affects what later positions can do with apparently similar resources.

This dependence should be distinguished from determinism. Earlier conditions constrain and enable later pathways without uniquely fixing them. Institutions can be reformed, standards can be replaced, relations can be renegotiated, technologies can disrupt established complementarities, and collective action can create new pathways. Historical dependence therefore concerns structured contingency: some futures become easier, harder, cheaper, more legitimate, more intelligible, or more reachable because of inherited configurations.

Sequence can matter even when the same components eventually appear. Introducing a technology before establishing governance institutions can produce a different relational configuration from introducing the same technology after such institutions have stabilized. Building infrastructure before a community has meaningful participation rights can create different dependencies from building it through participatory planning. A financial return received before capability formation may be consumed or captured differently from the same return received after complementary capacities exist. Historical dependence therefore belongs to the interpretation of value, not merely to background chronology.

The chapter's earlier analyses of accumulation, concentration, harm, and re-epistemization also acquire a trajectory interpretation here. Cumulative advantage can alter later conversion conditions; historical harm can reduce the capacity to benefit from later opportunities; re-epistemization can reinterpret earlier events and thereby change current institutions or compensation. A present value judgment can thus depend simultaneously on inherited material conditions and on historically changing understandings of those conditions.

14.15.5 Propagation

Propagation concerns the extension of value-bearing effects beyond their initial point of generation or realization. Section 14.5 distinguished transfer, transmission, and propagation. In a spacetime-oriented analysis, propagation additionally requires attention to where effects can reach, through which relations and infrastructures, at what speed or delay, across which scales, and with what transformation along the path.

Propagation is rarely homogeneous. Effects can attenuate because channels are weak, maintenance fails, translation is costly, institutional access is unequal, or complementary capabilities are absent. They can amplify when network effects, shared infrastructure, repeated learning, cumulative legitimacy, or recursive investment create reinforcing conditions. They can also branch, with one generated condition producing several different effects across positions. Propagation therefore has topology and incidence: who is connected, which paths are open, which interfaces transform the effect, and which positions remain inaccessible matter to the resulting value profile.

Spatial distance is only one component. A geographically nearby group can remain institutionally, linguistically, legally, technically, or epistemically distant from a value-generating process. A geographically distant organization can be tightly connected through standards, digital infrastructure, contractual relations, or shared institutions. Propagation analysis therefore needs relational distance and mediated accessibility in addition to location. Chapter 15 will formalize these distinctions more directly.

Propagation also interacts with value plurality. A process can propagate financial value while relational or ecological costs remain localized. Knowledge can propagate broadly while the capability to act on it remains concentrated. Institutional standards can propagate across organizations while the authority to revise them remains centralized. A system-level description of successful propagation can therefore conceal uneven conversion conditions and asymmetric incidence.

The historical path of propagation matters as well. Early recipients can become intermediaries that shape later access. A standard adopted at one stage can determine which later technologies remain compatible. Information passing through successive institutional layers can be compressed or reclassified. Effects can cross jurisdictional boundaries and encounter new legal or normative conditions. Propagation is therefore better represented as a sequence of transformations across positioned relations than as simple diffusion from a center.

14.15.6 Recirculation

Recirculation adds recursion to the trajectory picture. Section 14.7 defined recirculation as re-entry of an earlier value-bearing condition into later maintenance, regeneration, coordination, conversion, or generation. In a generative-spacetime perspective, the important point is that such return rarely closes a perfectly repeating loop. The process re-enters a world already changed by the preceding cycle.

A financial surplus reinvested in new capacity changes the productive base on which the next return is generated. Knowledge reused in later research can be re-

vised, combined, or institutionalized. Trust developed through prior cooperation can reduce later coordination burdens but can also create dependency or exclusion. Ecological regeneration can restore productive conditions while remaining vulnerable to future pressures. Institutional learning can alter the rules through which subsequent cases are processed. Each return therefore has memory: the next cycle begins from a historically transformed configuration.

This observation qualifies circular representations. A cycle diagram can be useful for identifying return pathways, but repeated circulation should not be interpreted as movement around an unchanged circle unless the evidence supports that simplification. Recursive value processes can drift, expand, contract, bifurcate, stabilize, or transform their own rules. They can also import resources and export burdens across the chosen system boundary. A cycle that appears self-sustaining at one analytical scale may depend on external ecological, labor, financial, or epistemic conditions at another.

Recirculation also creates temporal layering. Some returned conditions act quickly, while others mature slowly. Financial returns can be reinvested before institutional learning becomes visible; ecological restoration can lag behind economic extraction; capability returns can persist after a funding stream ends; reputational effects can accumulate across repeated episodes. These heterogeneous tempos mean that a single cycle length can be misleading. Several overlapping cycles can coexist, interact, and create phase mismatches among value forms.

A process-oriented account therefore treats recirculation as historically recursive rather than mechanically circular. This formulation preserves the chapter's distinctions among value forms and the possibility that recirculation can regenerate one form while depleting another. It also creates a direct bridge to Chapter 15's analysis of heterogeneous presents, temporal order, path dependence, delayed generation, and multiscale spacetime.

14.15.7 Generative Spacetime

The preceding subsections motivate a bounded use of *generative spacetime* within value analysis. The term names an analytical problem that emerges when economic processes must be represented through relations among events, historical order, reachability, distance, scale, delay, and changing possibilities rather than through isolated states alone. Chapter 15 will develop this problem as an independent substantive framework. The present subsection states only the interface required to close the theory of generative value.

For value analysis, four features are especially important. First, *event order* can matter: generation, recognition, conversion, and return need not be interchangeable when their sequence changes. Second, *accessibility* can matter: a value-bearing condition can exist while remaining unreachable to a position because the relevant relational, institutional, spatial, technical, or temporal pathway is blocked. Third, *distance and scale* can matter: propagation and incidence can change as a process crosses organizations, jurisdictions, communities, technologies, generations, or ecological systems. Fourth, *history can transform the space of continuation itself*: earlier events can change which later relations, actions, and pathways are admissible or

practically reachable.

These features suggest why a value-process trajectory can require richer structure than a time series. A time series orders observations by clock time, which can be sufficient for many empirical problems. Other problems require additional relations: which event enabled another, which process depended on a prior institution, which pathways were reachable only through intermediaries, which events were concurrent rather than sequential, and which later options were created or foreclosed. A partially ordered event representation, a network, a multiscale historical model, or another formalism can sometimes preserve these distinctions more adequately. The choice of representation remains method-dependent rather than prescribed by GRE.

The spacetime language also permits a stronger account of *where* value processes occur. Location can be territorial, organizational, institutional, relational, epistemic, technological, or represented through several such dimensions at once. The relevant notion of distance therefore depends on the process under study. Two actors can be geographically close and institutionally distant, or geographically distant and technically adjacent. Similarly, two events can be close in clock time while separated by many institutional or relational transformations.

Generative spacetime further connects value to possibility. Earlier sections developed option value, generative opportunity, and historical transformation. A present process can alter not only realized outcomes but also the architecture of later possibilities: it can create new capabilities, interfaces, institutions, relations, constraints, or degrees of freedom. In this sense, economic history concerns changes in the conditions under which later histories can unfold. Chapter 15 will make this claim more precise through trajectories, causal and generative accessibility, partial temporal order, path dependence, and structural transformation.

This interpretation remains under ontological suspension. GRE does not require the social world to possess a literal metric spacetime, a fixed-dimensional manifold, or a direct analogue of physical causality. Physical and geometric formalisms can provide structural insight when their assumptions and translation limits are explicit. Historical narratives, qualitative process tracing, network models, event structures, spatial analysis, dynamical systems, and computational simulations can also represent generative spacetime at different levels of abstraction. The adequacy of a representation depends on the research question and evidence.

Proposition 14.38 states the resulting chapter-level scope condition.

Proposition 14.38 (Spatiotemporal adequacy of value-process analysis)**.** *Within GRE, value analysis should preserve temporal order, delay, historical dependence, relational or spatial reachability, scale, and trajectory structure when those features materially affect the generation, manifestation, transmission, conversion, recirculation, accumulation, dissipation, harm, evaluation, or return under study. Such preservation can be qualitative, historical, empirical, formal, or computational and does not require a physical spacetime ontology. A static or lower-dimensional representation remains adequate when omitted spatiotemporal distinctions do not materially alter the claim being made.*

Proposition 14.38 closes Chapter 14 with the same proportionality principle that has guided its treatment of value forms, measurement, and formalism. GRE does not require maximal historical or relational complexity for every valuation problem. It

requires analytical resolution proportionate to the phenomena that materially shape the claim. A current price can be sufficient for one question; another may require reconstruction of generation, conversion, propagation, delay, accumulation, harm, and long-horizon return across several positions and scales.

The chapter has therefore developed value as plural, relational, generative, transmissible, convertible, recirculating, cumulative, vulnerable to dissipation and extraction, historically revisable, and capable of returning through later processes. The remaining task for Part V is to provide the spatiotemporal grammar through which these processes can be represented together with allocation, relations, institutions, and intervention. Chapter 15 undertakes that task by developing events and processes, trajectories, heterogeneous presents, relational distance, accessibility, sequence, path dependence, delayed generation, spatial propagation, structural transformation, multiscale organization, and the spacetime of value and intervention.

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