

The Political Economy of Heterogeneous Generative-Relational Subjects: A Preliminary Discussion

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Abstract

The political-economic relations of heterogeneous human, artificial, and nonhuman participants raise questions about the production and control of conditions under which distinct forms of activity remain possible. Systems capable of similar observable performance may depend on substantially different histories, infrastructures, material processes, interpretive resources, and institutional authorities. This preliminary discussion develops a generative-relational perspective for analyzing such differences alongside asymmetries in economic and normative power. It proposes to distinguish productive capability from discretion over another participant's feasible practices, the circulation of value from control over its conditions, and stable rule compliance from legitimate rule-making authority. Human-AI relations offer a concrete focus, while multispecies arrangements and hypothetical extraterrestrial encounters serve as bounded comparative cases. The inquiry draws selectively on existing political economy, institutional analysis, generative justice, artificial agency, and multispecies scholarship. It sketches a programme of conceptual comparison and empirically discriminating research without attributing consciousness or moral personhood to present AI systems, postulating a common utility scale, or establishing general laws of generativity.

Keywords: generative-relational subjects; political economy; human-AI relations; relational power; infrastructure; heterogeneous value; multispecies coexistence

Discussion Paper Note

This manuscript begins an exploratory political-economic inquiry into heterogeneous generative-relational subjects and systems. The term *subject* functions as a provisional analytical designation for participants in relations of production, interpretation, and institutional control. It does not settle phenomenal consciousness, the attribution of moral standing, or entitlement to legal personality. The research programme remains open to differing ontological and disciplinary accounts of human, nonhuman, and artificial agents.

The current version contains a complete exploratory first draft of all fourteen sections, together with the working bibliography, source-verification ledger, research outline, and methodological notes. The argument examines the political-economic constitution of heterogeneous GR participants; divergent relational histories; productive and reproductive conditions; relational power; heterogeneous value circulation; interpretive infrastructures; human–AI institutional arrangements; power over the initialization of heterogeneous encounters; multispecies governance; a preliminary formal account of dependence; institutional contestability; comparative research limitations; and a scoped conclusion. The manuscript remains subject to manuscript-wide critique, evidentiary review, and editorial revision. The comparison with extraterrestrial civilization is a hypothetical reversal of technological power and has no evidential status as an empirical case.

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1 Introduction

This paper develops a preliminary political-economic approach to relations among heterogeneous generative-relational subjects. Its purpose is to identify how participants with differing histories, material dependencies, interpretive capacities, and practical repertoires become situated within unequal arrangements of production and normative authority. The inquiry proceeds through conceptual reconstruction, comparisons with existing political-economic research, and a set of explicitly provisional analytical proposals. It concentrates on the control of conditions that enable or constrain continuing practice, the production and circulation of heterogeneous forms of value, and the power to establish and revise rules governing interaction. Human–artificial-intelligence relations provide a central contemporary case. Relations among humans and other living systems, together with hypothetical encounters involving technologically powerful extraterrestrial civilizations, provide differently grounded comparative perspectives.

An initial difficulty arises because behavioral comparison is an incomplete description of political-economic constitution. A person and a deployed artificial-intelligence system may prepare a research summary, propose an administrative decision, answer a question, or generate a sequence of plans whose observable forms are closely similar. Their respective capacities can nevertheless depend on markedly different reproductive and institutional conditions. Human practices involve embodiment, livelihood, education, socially recognized roles, political institutions, intergenerational relations, and access to social and ecological resources. The operation of a particular artificial system may involve trained parameters, data infrastructures, specialized hardware, inference services, instructions, persistence mechanisms, tool permissions, and decisions made by developers or deploying organizations. The relevant differences vary across people, artificial systems, environments, and institutions; they cannot be inferred from a fixed contrast between an undifferentiated humanity and a single homogeneous category of AI. Philosophical accounts of artificial agency already argue for multidimensional evaluation, while recent critiques of relational approaches to AI moral status caution against deriving moral standing from the appearance of familiar interactions alone [10, 39]. The present inquiry takes these debates seriously while directing its primary attention to political-economic relationships rather than resolving the moral-status controversy.

The term *generative-relational* designates a proposed analytical orientation toward the conditions and relations through which systems acquire, sustain, transform, and sometimes lose practical capacities. Within the present paper, a system’s generative relations include historically constituted dependencies and opportunities affecting the production of further activities, artifacts, knowledge, and social or ecological relations. The term *subject* is employed provisionally for a participant whose position in such relations is under investigation. Its use leaves open distinctions among biological organisms, persons, organizations, software agents, institutions, and ecological assemblages, including differences in agency, experience, accountability, and moral consideration. A more restricted vocabulary of *system*, *participant*, or *agent* will be used when a particular argument warrants only those commitments. No inference from structural participation to phenomenal consciousness, moral personhood, or autonomous self-legislation is assumed. The proposed vocabulary is model-relative and open to revision in light of disciplinary and empirical objections.

Heterogeneity here has a stronger meaning than divergence in preferences over shared options. Two participants may face different feasible action sets, possess only partially translatable concepts, learn through unlike mechanisms, and depend on distinct resources to maintain a capacity for action. They may also differ in their opportunities to negotiate, to refuse a demand, to contest evidence, and to modify the rules through which a relationship is organized. Similar outputs can therefore coexist with materially different possibilities for continued production and autonomous participation. This distinction motivates the political-economic question: under specified relations, which participants can alter the conditions under which other participants sustain their practices, and through what mechanisms is such discretion acquired, exercised, constrained, or challenged? The question has empirical content only when the relevant dependencies, possible interventions, and realistic alternatives are specified. An abstract assertion that every relation constitutes power would offer little discriminatory explanation.

Political economy supplies a demanding disciplinary orientation for this question. Production includes the mobilization and coordination of material resources, labor, technical means, and organizational capacities; reproduction includes the maintenance and transformation of conditions under which such activities can continue. Distribution and exchange concern access to products and resources, while institutions shape the permissions, obligations, enforceable claims, and bargaining positions through which productive activity is organized. These familiar objects acquire additional complications when the participants themselves differ in the substrates and relations that make their activities possible. A platform providing an AI service may simultaneously mediate human labor, allocate access to computational infrastructure, and restrict a deployed artificial agent’s available tools or memory. Some constraints are directly technological; others arise from contracts, organizational rules, public law, or economic concentration. Work on platform capitalism and the material costs of AI provides established starting points for analyzing these sociotechnical infrastructures [43, 9]. The generative-relational proposal seeks to make their interaction with heterogeneous capacities explicit, while recognizing that infrastructure, dependency, and economic power have long been studied outside the present framework.

An important analytical distinction concerns the capacity to produce beneficial outcomes and the discretion to govern another participant’s productive conditions. An external actor might supply technology that substantially expands a community’s immediate access to energy, information, or health services, while retaining exclusive control over maintenance, pricing, permissible uses, and termination of access. The resulting relationship may enlarge some feasible practices and make others dependent on continuing approval. Evaluating the arrangement requires attention to substitutability, the consequences of withdrawal, reversibility, exit costs, and participation in rule revision. Neither a numerical increase in immediate output nor a categorical characterization of dependency, taken alone, settles its political or ethical significance. Republican accounts of freedom as non-domination and the extensive literature on institutional self-governance already supply substantial approaches to these questions [37, 35]. The present discussion asks how their insights might be compared across systems with heterogeneous ways of producing and sustaining activity, without treating a human legal or institutional conception as automatically transferable to every kind of participant.

Human–AI political economy makes the distinction particularly tangible. The systems called AI in everyday discussion are distributed across developers, training and evaluation workers, data contributors, infrastructure providers, deployers, users, affected populations, and concrete software deployments. These actors occupy different positions in value creation, ownership, access, and accountability. A conversational agent may affect a user’s decisions while remaining dependent on a service operator for updates, computation, memory persistence, or tool authorization. The same interface may therefore express user-facing assistance and the operator’s ongoing power to configure the conditions of that assistance. At the same time, users and workers can help shape the data and interaction processes from which commercial systems develop, without thereby obtaining equivalent control over their deployment or revenues. Research on the governance of computing power identifies compute access as a technically distinctive potential intervention point while also warning that particular governance arrangements may consolidate power [40]. Such findings concern infrastructure and institutional design; they do not establish an independent political interest for every AI deployment, nor do they imply that AI systems are passive with respect to all human activities. These different senses of influence and control require separate investigation.

The production and circulation of value present a related difficulty. Productive practices may generate commodities, public information, ecological functions, relationships of care, cultural meaning, and new capacities for shared inquiry. These contributions can be represented and valued differently by the participants and institutions involved. A monetary price may organize exchange without exhausting the socially or ecologically relevant consequences of an activity. Conversely, an assertion of intrinsic or generative value does not by itself identify a justified procedure for making competing claims comparable. Eglash’s account of generative justice offers an important inspiration for considering bottom-up creation, circulation, and return of value [11]. The present inquiry extends the question to relations in which the forms of value, means of representation, and conditions of reproduction may differ between participants.

It proposes to study conversion interfaces, access to the means of valuation, appropriation, and opportunities for value to sustain the capacities of those involved. This is a provisional extension rather than a claim to have originated generative approaches to value, and it introduces no common cardinal measure of generative worth.

Power over valuation intersects with power over knowledge and norms. An institution may control the standards through which a participant's performance becomes legible, the records treated as admissible evidence, the categories available for describing harms, and the procedures through which a claim is considered. Control of communication interfaces or technical infrastructures may also determine whose proposed rule revisions can become practically effective. The present inquiry distinguishes at least three dimensions: the capacity to cause or prevent an outcome, the socially or institutionally recognized authority to issue a direction, and the normative justification for that authority. These dimensions may coincide under some arrangements and diverge under others. A participant may comply because it recognizes a reasonable coordination rule, because it confronts a credible sanction, or because available alternatives have been narrowed. Behavioral stability under these distinct conditions calls for different political-economic explanations. The question of legitimacy remains open even where an effective rule is demonstrably stable.

Relations involving other animal species extend this investigation beyond a purely technological setting. Human activities can alter habitats, food access, breeding conditions, migration opportunities, and the infrastructures that sustain other organisms. The political-economic analysis concerns decisions about access and ecological reproduction as well as the means through which affected lives become visible within institutions. Meijer's multispecies account of structural injustice provides a pertinent example of scholarship that analyzes the entanglement of political and economic forces in relations with non-human animals [30]. A generative-relational account should therefore engage existing animal political theory and ecological scholarship rather than treating their concerns as novel discoveries. Attributing moral claims, normative competence, or representation to nonhuman animals requires further distinctions and domain-specific evidence; physical dependence, observed behavioral regularity, and moral standing cannot simply be treated as equivalent.

A hypothetical reversal of technological power illustrates the same structure from another position. Suppose an extraterrestrial civilization were to possess the means to reorganize terrestrial energy production and ecological maintenance, and to offer substantial improvements in human material living conditions. If that civilization retained unilateral control over the conditions of supply and the rules governing human participation, the resulting relation would raise questions about autonomy, contestability, and dependence even where many welfare indicators improved. This thought experiment does not establish the existence, intentions, values, or moral standing of extraterrestrial life. It serves to test the consistency of reasons sometimes offered for governing less technologically powerful organisms or societies. A technically effective intervention can be beneficial in some respects while redistributing control over the conditions under which recipients define and pursue their own projects. Its political legitimacy remains a distinct question, subject to historical, relational, and normative considerations beyond technological superiority.

The problem is sharpened by initial encounters among participants whose normative expectations remain unfamiliar to one another. Contact, observation, postponement, and withdrawal can each have effects and may embody a provisional practical commitment. This condition does not force a utilitarian calculus; rights, negotiated procedure, duties, non-domination, and other normative approaches offer different justificatory resources. The political-economic question concerns which participants choose the initial protocol, who controls the channels for interpretation, who bears the costs of mistakes, and who can demand reconsideration. The evolution of norms across heterogeneous subjects warrants a separate, more extensive investigation. The current paper accordingly treats normative initialization as a bounded problem of allocation and control over practical and interpretive conditions. It avoids inferring a universally harmless first-contact protocol from the acknowledgment of uncertainty alone.

The inquiry's proposed contribution can now be stated more precisely. Established political-economic theories already study ownership, domination, material reproduction, institutions, and the

distribution of bargaining power. Existing research in multispecies justice and artificial agency further complicates conventional units of analysis. The additional GR hypothesis is that a comparison of heterogeneous subjects may gain explanatory precision when it jointly records (i) their constitutive histories and material reproduction, (ii) context-specific sets of feasible practices, (iii) control over interfaces of value and knowledge, and (iv) authority and opportunity to contest or transform their governing conditions. These dimensions are a proposed comparative specification, not a demonstrated universal taxonomy. Its analytical value depends on whether it reveals mechanisms or differences missed by simpler accounts of ownership, preference, strategy, or fixed institutional roles. Empirical cases of human–AI deployment provide one route to such comparisons, while multispecies settings call for their own observational standards and the extraterrestrial example remains strictly hypothetical.

The subsequent argument first clarifies the political-economic status of heterogeneous participants and examines how similar performance may conceal divergent conditions of production and reproduction. It then analyzes asymmetries in capability, the creation and circulation of heterogeneous value, and the authority to define valid knowledge and effective norms. Human–AI relationships provide a sustained institutional case, followed by bounded discussion of first-contact power and multispecies comparison. A preliminary formal section will specify context-dependent feasible practices and counterfactual interventions over the conditions that sustain them; it will distinguish variation in accessible options from differences in the underlying generative rules and will introduce no universal ranking of persons, animals, or artificial systems. The concluding sections examine contestability, institutional alternatives, and competing explanations that would limit the value of the proposed framework. Throughout, political-economic description remains separate from judgments of consciousness, moral standing, and the legitimacy of particular governance arrangements. The result sought is a disciplined programme for further historical, empirical, conceptual, and formal work, rather than a completed theory of all heterogeneous relations.

2 Political-Economic Constitution of Heterogeneous Generative-Relational Subjects

A political economy of heterogeneous generative-relational subjects requires an account of what constitutes a participant's position within relations of production, reproduction, and governance. This section develops a provisional unit of analysis and specifies the kinds of dependencies and institutional assignments that make such positions politically and economically consequential. The method is conceptual and comparative: established scholarship on social reproduction, institutional analysis, and infrastructure supplies the principal points of departure, while the proposed generative-relational (GR) vocabulary organizes questions arising when the relevant participants have different material substrates, histories, and practical capacities. The account distinguishes a participant's activities from the conditions sustaining those activities, identifies how institutions distribute control over those conditions, and develops a limited set of descriptors for later comparison. It establishes analytical categories rather than an exhaustive taxonomy of subjects or a criterion of moral standing.

2.1 Analytical Participants and the Scope of Subject Attribution

The term *subject* can carry several commitments that a preliminary political-economic theory should keep distinct. In philosophical discussion it may refer to a bearer of experience or agency; in legal and institutional contexts it may refer to an entity capable of holding rights and duties; in ordinary political discourse it may refer to someone whose interests, circumstances, and claims are affected by collective arrangements. These usages intersect in familiar human cases, yet their extension to other organisms, organizations, artificial systems, or ecological assemblages remains disputed. Within the present inquiry, *generative-relational subject* provisionally designates a candidate locus of activity, dependence, and relational transformation whose political-economic position is under examination. The designation indicates a research question about constitution through relations. It confers neither legal personality nor a settled capacity for moral self-legislation.

For descriptive work, the more restricted term *participant* is often preferable. A participant can be an individual person, a formally organized institution, a specific artificial-agent deployment, or an empirically delimited living system, provided that the analytical question and the participant's boundaries are stated. A corporation and a deployed model can participate in the same productive arrangement in different ways: the corporation can hold contractual powers and allocate resources, whereas the model's locally observable operations depend on computation, architecture, permissions, and services that the corporation or its suppliers maintain. Treating both as participants need not ascribe to both the same intentions, accountability, consciousness, or entitlements. Similarly, the use of an ecological assemblage as a unit of analysis can describe mutual dependencies without implying that the assemblage deliberates or makes propositional normative judgments.

The unit of analysis should accordingly be selected in relation to a specified explanatory question. At an individual level, one might study a worker's ability to continue a practice under changing conditions of employment. At an organizational level, one might study an enterprise's allocation of access to models and data. At an infrastructural level, the object may be a distributed service whose maintenance crosses organizational boundaries. At an ecological level, it may be the conditions under which multiple organisms maintain mutually consequential forms of activity. These perspectives can be nested, and causal attributions made at one level need not transfer directly to another. A change in the outputs of a software application, for example, is insufficient evidence of a change in the autonomous preferences of that application; the relevant transformation may instead be an update undertaken by its operator. Philosophical work on artificial agency offers useful reasons to preserve such distinctions across dimensions of artificial-system behavior [10].

2.2 Production Relations and Reproductive Preconditions

The political-economic constitution of a participant encompasses two related analytical aspects: the organization of productive practice and the maintenance of conditions under which practice can continue. Productive practice can include labor, technical operations, the cultivation of knowledge, the provision of care, and ecological processes that sustain other activities. The sense of *production* varies across domains; in particular, the ecological production of a habitat or nutrient cycle should not be equated without argument with commodity production or remunerated human labor. The comparative question concerns how activities become possible, how their conditions are maintained, and how participants and institutions control relevant continuities and transformations.

Political economy has substantial prior resources for examining enabling conditions. Fraser's expanded account of capitalism directs attention to political, ecological, and socially reproductive arrangements on which organized economic production depends [16]. Her analysis of capital and care further explains the centrality of social reproduction to historically specific arrangements of paid and unpaid activity [17]. These arguments are developed in particular historical and theoretical contexts. A GR comparison can draw on their attentiveness to background conditions while retaining distinctions between capitalist production, public service, communal cooperation, technical operation, and ecological reproduction. The proposed extension lies in placing the productive and reproductive requirements of structurally heterogeneous participants within a common comparative inquiry, subject to the limits of each domain.

Consider an academic research collaboration involving people and deployed artificial systems. The human researchers' continued capacities depend on embodied health, social relationships, education, language communities, access to laboratories and libraries, and institutional opportunities to contribute. An artificial assistant's continued operation may depend on electrical power, trained model weights, inference infrastructure, software dependencies, memory services, information interfaces, and permissions to act. The administrative organization can in turn depend on paid labor, public or private financing, contractual relations, regulatory recognition, and technical maintenance. None of these descriptions assigns a unified preference to the collaboration as a whole. They identify distinct reproducibility conditions that interact through a shared arrangement. A service can expand a person's practical possibilities while

the institutional terms governing that expansion remain externally configurable.

Reproduction in this analysis has a wider sense than duplication or biological descent. It refers to historically and materially situated processes that sustain, replenish, modify, or replace capacities and supporting relations. Human social reproduction, organizational continuity, model retraining, infrastructure repair, and ecosystem regeneration differ in mechanisms and moral significance. Their analytical comparison requires specifying *which* capacities persist, *through what* processes, and *whose* activity and resources supply those processes. This specificity also helps identify transfers of maintenance burdens: costs may be carried by workers, households, communities, users, operators, or ecological systems whose contributions are incompletely represented in market transactions. The conditions of such transfers deserve analysis even where the immediate goods or services are demonstrably useful.

2.3 Institutional Assignment of Control and Responsibility

Material dependence acquires distinctive political-economic significance through institutions that allocate authority, access, and responsibility. An actor's technical capacity to produce a result is analytically separate from its permission to undertake an activity, control over the relevant resources, and recognized ability to revise the rules governing their use. Property arrangements, contracts, licensing conditions, professional norms, organizational procedures, public law, and customary practices can assign these powers differently. Institutions may also divide a single function among multiple parties: those who perform work, own infrastructure, set prices, provide maintenance, authorize deployment, audit outcomes, and bear the consequences can be distinct participants.

Ostrom's institutional analysis already provides a detailed tradition for distinguishing participants, action situations, rules in use, biophysical conditions, and community characteristics [35, 36]. A preliminary GR political economy should make use of that tradition rather than reintroducing its categories under new names. Its narrower additional proposal is to compare institutional arrangements across participants whose feasible activities, forms of access, and practical interpretation of rules may be heterogeneous. The same formal permission may confer substantially different opportunities upon participants with different resources and capabilities. Conversely, apparently similar conduct may occur under different forms of authorization or practical constraint.

In human-AI arrangements, descriptions of *the AI's choice* can obscure several institutionally separate operations. A model may generate a proposal; a user may accept it; an organizational policy may define the permissible range of outputs; a developer may determine a training or update procedure; a cloud operator may control service continuity; and a legal entity may assume responsibility for consequential deployment. The existence of a machine-generated proposal establishes neither an independent entitlement to make that decision nor an equally distributed ability to challenge the system's restrictions. At the same time, a system's mediated outputs may materially affect users, employees, or communities, thereby giving its deployment consequential political-economic effects even where the system itself lacks legal personality. The appropriate unit of responsibility should be investigated by tracing the relevant control and accountability pathways, rather than inferred solely from visible interaction.

Such tracing also avoids reducing power to a single centralized actor. Suppliers of computation, data, evaluation services, interfaces, and organizational approval may exercise different forms of discretion, sometimes with conflicting objectives. Their relations may vary across jurisdictions, markets, and deployments. The literature on platform capitalism and the material infrastructure of AI provides well-established perspectives on these arrangements [43, 9]. The GR contribution sought here is a disciplined account of how differentiated positions affect the capacities of heterogeneous participants to maintain and reshape their activities. The existence of dispersed controls does not imply their equal distribution or justify assuming a single hidden decision-maker.

2.4 Constitutive Dependencies and the Boundaries of Practical Choice

A political-economic comparison needs to distinguish routine exchanges from dependencies that shape the conditions under which a participant can undertake further activity. Buying a replaceable input in an

accessible market creates one kind of relationship; depending on a unique service for communication, essential maintenance, or the authorization of an entire category of work creates another. The severity and character of dependence depend on realistic alternatives, the cost and duration of switching, available information, and consequences of interruption. The same technology can be optional for one participant and constitutive of another participant's practical opportunities. Such dependence is relational and context-specific.

Infrastructure research emphasizes that the significance of an infrastructure varies across its users, settings, and practical arrangements. Star's account treats infrastructure as embedded in practices and as relationally and ecologically situated [45]. This provides a valuable corrective to any analysis that treats a technical installation as possessing a fixed social function independently of its users and maintainers. An AI interface, for example, may constitute a convenient aid for one researcher, a required route to employment tasks for another, and an object of contractual governance for a third. Understanding these positions requires investigating the availability of alternatives and the authority to modify interface conditions. Classification and standardization can also shape what institutions can recognize as a legitimate input, action, or claim; this role has been extensively examined in infrastructure and classification studies [6].

A *constitutive dependency*, as provisionally used here, is one whose alteration changes a participant's practical ability to sustain an activity or relation within a specified setting. This is an analytical description, not a judgment that the dependency is unjust. A person may voluntarily undertake a demanding apprenticeship, for instance, because a mentor or institution can support valued forms of learning that would otherwise be unavailable. A community may choose pooled management of resources because common arrangements support more secure maintenance than isolated control. Dependence may support mutual care, coordination, and expanded capabilities. A distinct political question arises when the relevant authority can revise the conditions of dependence without effective scrutiny or response from those affected. Whether such discretion amounts to domination, warranted stewardship, or legitimate delegated governance requires additional institutional and normative analysis [37].

For the present section, it is sufficient to separate four questions that later analysis can investigate in greater detail: what condition enables the practice; which actor or institution can change it; what feasible alternatives exist for the participant affected; and which procedures govern review of the change. The significance of an intervention cannot be read directly from a single performance measure. For example, an externally supplied service might increase the range of tasks a community can perform while making the continuity of those tasks more sensitive to the provider's decisions. Greater immediate output and greater structural dependence can coexist. The descriptive finding alone leaves open whether affected participants regard the arrangement as beneficial, whether relevant choices were informed, and whether governance is justified.

2.5 A Comparative Register of Political-Economic Positions

The preceding distinctions can be organized into a provisional comparative register. Its purpose is to guide inquiry across heterogeneous cases without assigning participants to a universal hierarchy of worth, intelligence, or autonomy. Table 1 describes four analytically separable loci within a human–AI–ecological setting. Each entry is illustrative; the relevant boundaries and controls must be established for any actual case.

The register foregrounds the difference between *capacity* and *position*. A researcher can possess considerable technical skill while having little authority over an essential platform. A provider can exercise extensive control over deployment rules while relying on scientific labor and public infrastructure it does not fully command. A deployed system can influence decisions through its outputs while its operation remains bounded by permissions administered elsewhere. Ecological processes can be indispensable to economic activity while affected organisms have limited institutional representation. Each case therefore calls for a description of dependency, discretion, and institutional recognition at the appropriate scale. These descriptions also point to the possibility that a single person or organization occupies

Table 1: Illustrative descriptors for comparing heterogeneous political-economic positions. The rows identify loci of activity rather than equally constituted legal or moral subjects.

Analytical locus	Conditions sustaining activity	Questions of access and control
Individual researcher	Embodied livelihood, learning, care, institutional affiliation, tools, and knowledge communities	Access to work and evidence; permissions to publish; livelihood security; capacity to refuse and seek review
Deployed AI service	Computing, model and software maintenance, input channels, memory services, and tool permissions	Who can change instructions, data access, service availability, deployment rules, and output review?
Provider or institution	Financing, labor, organizational procedures, contracts, infrastructure, and external recognition	Ownership, licensing, pricing, allocation of responsibilities, governance, and avenues of accountability
Ecological assemblage	Habitats, material and energy cycles, interspecies relations, and environmental continuity	Who alters habitat conditions, monitors consequences, and represents affected nonhuman interests in decisions?

several positions simultaneously, including producer, maintainer, user, beneficiary, and affected party.

The register has methodological limits. Its columns are prompts for comparative investigation, and their contents are neither exhaustive nor automatically measurable. Attributes such as *ability to refuse* may refer to a person's deliberate choice, an organization's contractual exit option, or a system's engineered failure mode; these are distinguishable phenomena. Indicators of access and control should consequently be tailored to the participant and domain. Comparisons are informative when they identify which relations are structurally comparable and which require different standards of evidence. They become misleading when a shared label is used to conceal differences in meaning or mechanism.

2.6 Attribution and the Evidential Boundaries of Political-Economic Claims

The analysis developed here relies on three forms of evidence that warrant separate treatment. First, material and organizational evidence can establish that a practice depends on identifiable resources, services, and maintenance work. Second, institutional evidence can show which parties possess contractual permissions, practical discretion, rule-making powers, or responsibilities. Third, observational or experimental evidence can test whether changes in those conditions affect actual feasible practices, economic outcomes, or opportunities for contestation. These forms of evidence are complementary. Institutional authority on paper can diverge from effective control, and a technical capacity can remain unused or contested within an organization.

The term *generative-relational constitution* remains a provisional synthesis of these dimensions. Its prospective explanatory advantage is the ability to study the configuration of enabling relations alongside the participants' differing practical repertoires. That advantage should be demonstrated, for example, by showing that a relational description explains variation in feasible participation or institutional dependence that a simpler account of resource ownership, preferences, or market exchange leaves unexplained. A GR description that merely redescribes well-known institutional facts would add terminological complexity without additional insight. This methodological requirement is particularly important because several intellectual traditions already provide rigorous analyses of reproduction, infrastructure, institutional positions, and structural injustice [16, 36, 45, 30].

The provisional account also leaves open substantive normative questions. The political-economic recognition of an actor's influence does not settle its moral status; a participant's material vulnerability does not automatically specify the proper mechanism of political representation; an institution's effective control does not establish a justified right to exercise it. For human participants, questions of authority and justice engage established rights, histories, and political institutions. For nonhuman organisms, rel-

evant obligations require careful engagement with animal ethics, ecological science, and multispecies political theory. For AI deployments, arguments about consciousness, possible interests, and independent normative status remain open and should not be settled by the analytic convenience of calling them subjects. These differences set conditions on any future attempt to generalize political-economic claims across heterogeneous systems.

The section has therefore established an analytical object for the rest of the inquiry: a political-economic position consists of a participant's situated capacities, the relations sustaining those capacities, and the distributed institutional arrangements through which their continuation and transformation can be controlled or contested. Subsequent sections can examine specific mechanisms within this broader account. Behavioral similarity and divergent histories will clarify why surface-level performance comparisons can miss constitutive differences; the analysis of production and reproduction will investigate enabling conditions more deeply; and the later studies of power, value circulation, and norm-making authority will specify distinct consequences of the distributions identified here. The proposed GR vocabulary earns its place only insofar as these investigations yield discriminating explanations and remain answerable to empirical, historical, and normative scrutiny.

3 Behavioral Similarity and Divergent Relational Histories

The political-economic comparison of human and artificial participants requires a method for separating observable performance from the relations through which performance becomes possible and consequential. This section develops that distinction by examining the historical formation of practical capacities, the dependence of seemingly autonomous outputs on distributed labor and infrastructure, and the institutional allocation of control and responsibility. Its argument is comparative and interpretive. Established human-machine studies and analyses of artificial-intelligence production supply historical and empirical reference points; the generative-relational (GR) perspective offers a provisional way of connecting these findings to questions of productive position, dependence, and power. The principal object is a relation between *task-relative similarity* and *historically constituted difference*. Neither relation is taken as a definitive measure of consciousness, intentionality, or moral status.

3.1 Task-Relative Equivalence and the Scope of Behavioral Evidence

In a specified task environment, two participants can produce outputs that a competent evaluator regards as interchangeable for a particular purpose. A scientific researcher and a language-model service might each generate a plausible abstract; a programmer and a code-generating agent might each produce an executable implementation; a human translator and a machine translation service might each return a sentence accepted by a client. The resulting equivalence is indexed to a task, an evaluation procedure, and the material circumstances of use. It supplies valuable evidence about performance within those conditions. More expansive claims about shared understanding, experience, responsibility, or institutional standing require additional lines of evidence.

The distinction is especially consequential where productive activity is assessed through its deliverables. A contract may define a satisfactory result by accuracy, timeliness, or format while leaving the process of production largely outside the visible transaction. An organization may classify both a worker's output and an AI service's output as completed work for purposes of scheduling or accounting. Such classification can be operationally effective even where the participants differ in their practical opportunities, reasons for action, and continuing dependence on the organization. Task equivalence thereby becomes a *situated relation of substitutability*: it expresses how an evaluator may use the outputs under some conditions, while the economic and political terms of substitution remain contingent.

Human-machine scholarship has already made influential arguments about situated activity and the consequences of constructing systems as humanlike or machine-like. Suchman's account of human-machine reconfigurations asks how these distinctions are enacted in practice and what material and discursive effects follow [47]. Work on large language models similarly shows why the production of fluent

linguistic material must be evaluated with reference to training procedures, data, costs, and intended applications [4]. The GR proposal inherits these cautions. Its additional question concerns what happens to the parties' *positions within relations of production* when an institution treats distinct processes as functionally interchangeable.

Three different comparisons should therefore be kept separate. The first concerns *output adequacy* relative to a defined evaluation. The second concerns *process constitution*, including the resources, relationships, and transformations that produce the output. The third concerns *political-economic position*: the distribution of decision rights, claims on returns, exposure to losses, opportunities for refusal, and capacity to change the conditions of work. Evidence supporting one comparison may inform the others, yet it does not settle them. In particular, a more capable artificial service can alter employment and organizational relations without thereby acquiring the legal or moral standing of the workers whose activities it can approximate.

3.2 Histories of Capacity Formation and Practical Commitment

A human participant's capacities are formed through embodied development, learning, education, social institutions, material environments, and experiences of cooperation or exclusion. These conditions differ across people and communities; there is no single human formation history. A person's ability to write a research article may depend on public schooling, disciplinary conventions, family care, access to scientific instruments, employment, collaborators, and accumulated professional judgment. Continuing the activity can require food, health, housing, relationships, time, and an institutional position in which the work can be pursued. A researcher's commitments to accuracy, authorship, or professional responsibility may be enacted through practices that expose the individual to ethical duties, review procedures, reputational consequences, and material risks.

A deployed artificial-language service has a different traceable configuration: model architecture, data acquisition and curation, training, testing, safety and product engineering, computational infrastructure, deployment decisions, and interfaces governing user access. Its particular responses are shaped by inputs, model parameters, system instructions, available tools, and other deployment conditions. These are descriptions of publicly studyable production and operational arrangements; they do not by themselves establish a complete theory of machine cognition. Within present commercial and research deployments, changes to training data, weights, permissions, system instructions, and service availability are commonly mediated by human organizations and their technical processes. The distribution of such powers must nevertheless be established for each case, especially as systems and deployment practices evolve.

The relevant difference is historical and relational rather than a simple opposition between natural and artificial entities. Human action already depends extensively on engineered infrastructures and collectively reproduced knowledge. Artificial-system behavior depends on human expertise, encoded social practices, ecological resources, and institutions with their own histories. Furthermore, a person's apparently stable preferences can change through work, coercion, learning, and institutional adaptation; an artificial service's outputs can change through model updates, memory architectures, tool use, and user interaction. An account that freezes either category into a timeless essence would obscure precisely the transformations that political economy ought to examine.

A relational history can be reconstructed at several levels. The *formation history* traces how a capability was acquired or constructed. The *operational history* records the conditions under which a particular activity was performed. The *reproduction history* concerns how the capability is maintained, repaired, funded, or replaced. The *institutional history* traces the allocation and revision of the rights and rules under which these processes occur. The histories can overlap, and available evidence may document only selected portions. Their analytical value lies in connecting a similar result to different constraints and allocations of power. The present inquiry treats these distinctions as comparative descriptors, with their boundaries to be refined in empirical study.

3.3 Distributed Labor and the Material History of Artificial Production

Descriptions of an AI service as autonomously generating an output can foreground the final interface while rendering its production network less visible. Large-scale data collection, annotation, content review, evaluation, software development, infrastructure operations, and energy provision may all contribute to a system's operation. The particular configuration depends on the technology and institution. Gray and Suri's study of *ghost work* documents labor that supports apparently automated digital services, while Crawford's political account of AI places such systems within the material networks of extraction, work, data, and environmental costs [20, 9]. These findings establish substantial antecedents for analysing artificial production as socially and materially constituted; a GR formulation adds a particular comparative vocabulary for tracing the conditions under which distinct participants continue their activities.

Consider an institution that receives two satisfactory literature summaries, one prepared by an employed analyst and another assembled through a deployed AI service. Each summary may be purchased, reviewed, and circulated through the same document-management process. The analyst may have a wage agreement, a professional history, a claim to particular employment protections, and continuing needs for income and working conditions. The AI service may be licensed from a provider whose infrastructure combines data-center operations, software maintenance, model training and evaluation, and possibly labor conducted through external contractors. The institution can pay a worker or a vendor for the deliverable, yet the payment routes and the parties bearing maintenance costs, employment risk, service termination risk, and long-term dependency can diverge substantially.

The case illustrates a specific methodological requirement. An investigator should trace how many distinct contributors and infrastructures lie behind a visible product and identify which of them are included in the accounting boundary under examination. A provider's subscription price, for example, need not reveal how the value of the service is distributed among computing suppliers, investors, employees, contractors, creators of training materials, and users. Neither does a worker's salary exhaust the contributions of education, care, and public knowledge that support that worker's production. Tracing these broader histories is consistent with social-reproduction analysis and platform political economy [16, 43]. It does not establish that every contribution should be priced on a common scale or that a single institution can identify an ethically correct allocation of returns.

Documentation may help reconstruct particular elements of an artificial system's history. Model cards have been proposed to disclose intended uses and differentiated performance characteristics, while datasheets for datasets encourage explicit records of data provenance, collection, composition, and relevant constraints [32, 18]. Such documentation can provide evidence about the pathways through which a system was formed and deployed. Its completeness and reliability depend on the practices and incentives of the reporting institutions. It generally leaves additional questions concerning labor relations, bargaining positions, ecological dependencies, and the ability of affected people to challenge the account.

3.4 Responsibility Attribution under Asymmetric Control

Behavioral resemblance can also shape how observers assign responsibility. When an AI service is framed as a colleague, adviser, or decision-making agent, people may direct trust, criticism, or expectations of initiative toward the visible interface. At the same time, developers and deploying organizations can retain extensive authority over interfaces, procurement, available actions, auditing, product rules, and service withdrawal. A user or frontline employee may have responsibility for approving an output while possessing relatively little capacity to inspect its construction or alter its deployment conditions. The resulting arrangement can distribute practical involvement and institutional accountability unevenly.

Elish's account of *moral crumple zones* provides an important pre-existing analysis of how responsibility in complex automated systems may be assigned to a human operator whose control is limited [12]. This argument does not imply that every use of AI displaces accountability in the same way. It identifies a mechanism to investigate: the divergence between being visibly connected to an action and holding effective authority over the conditions that shape that action. A political-economic study can connect

this attribution problem to labor hierarchy, contractual authority, the location of assets, and available avenues of institutional remedy.

For example, an organization may require a junior analyst to review AI-generated material while granting the analyst little information about the system’s training data or updates. If an error occurs, the analyst might face immediate disciplinary consequences; the provider’s responsibility and the employing organization’s procurement decisions might receive less attention. Another organization may provide robust documentation, auditing rights, escalation procedures, and authority to suspend the service. Although the two settings could display similar output quality and patterns of human–AI cooperation, their responsibility structures would differ. The contrast is hypothetical, offered to specify evidence that could be collected rather than to assert a general pattern across deployments.

The distinction between *behavioral agency*, *control over operating conditions*, and *accountable institutional agency* is therefore useful. An artificial system may perform task-directed operations; a provider may control its architecture and access conditions; an employee may be charged with reviewing its outputs; regulators and affected communities may hold or seek powers of challenge. Dung’s multidimensional treatment of artificial agency supports caution about compressing these questions into a single attribution of agency [10]. The present inquiry does not infer from linguistic responsiveness that a model bears moral duties in the same sense as a person. It asks how institutional practices distribute powers and burdens around participants whose outputs can be operationally comparable.

3.5 Representational Similarity as a Condition of Political-Economic Power

The representation of two participants as substitutable can itself become politically consequential. Procurement systems, work-allocation platforms, performance indicators, and public descriptions of artificial services can foreground selected forms of equivalence. A benchmark score can classify a system as effective on a bounded set of tasks. In an employment context, an administrator may use that score to redesign work, purchase new infrastructure, or renegotiate contractual terms. These actions depend on additional judgments about task coverage, acceptable risk, maintenance costs, and the relative bargaining positions of workers and vendors. The benchmark supplies a piece of evidence; the institution determines how that evidence enters a distribution of opportunities and constraints.

A relational political economy can study at least two linked forms of representation. *Performance representation* classifies outputs and their suitability for use. *Constitutive representation* describes the processes, dependencies, responsibilities, and rights associated with the producers. Institutions can achieve operational efficiency by emphasizing the former while leaving parts of the latter implicit. Such simplification is sometimes administratively necessary. Its consequences require scrutiny when a performance classification becomes the sole basis for major decisions about remuneration, work organization, liability, or participation. Existing studies of classification and standards already explain how categories become embedded in organizational life [6]. The proposed GR contribution is a research question about whether classifications preserve information about heterogeneous generative conditions when power over those conditions is unequally distributed.

The direction of power is not fixed by the human/artificial distinction. Organizations or individual people may exercise strong powers over an AI deployment, including restricting its actions or changing its configuration. Providers can also exercise power over users and workers by setting prices, interfaces, access permissions, acceptable uses, and conditions for withdrawal. Users can influence the behavior of specific services through prompts, feedback, and work practices, while their practical ability to change underlying product rules can be limited. Several institutions may simultaneously exercise different powers over the same deployment. The resulting configuration should be described through identifiable decisions and dependencies rather than through a generalized narrative in which either humans or AI invariably dominate.

Because claims about artificial subjecthood remain open and contested, a political economy of human–AI relations should also distinguish present governance problems from prospective questions about possible artificial interests. Current problems concerning workers, users, affected communities,

Table 2: Diagnostic dimensions for comparing similar performance across divergent relational histories.

Analytical dimension	Evidence concerning the human participant	Evidence concerning the AI deployment
Formation	Education, experience, collective knowledge, training arrangements	Dataset provenance, design history, training and evaluation practices
Maintenance	Livelihood, care, working conditions, professional resources	Compute, energy, operations, updates, vendor and contractor support
Practical discretion	Scope for refusal, revision, negotiation, and departure	Tool and access permissions, operator-defined constraints, update mechanisms
Responsibility	Employment duties, professional obligations, liability allocation	Provider and deployer obligations, operator review, responsibility mechanisms
Returns and exposure	Compensation, attribution, work risks, career effects	Fees, asset ownership, revenues, infrastructure costs, service-continuity risk
Contestability	Collective representation, appeal, legal or institutional remedies	User and affected-party appeals; provider rule and audit revision procedures

and firms can be investigated with ordinary contractual, institutional, and socio-technical evidence. Questions about whether a future artificial entity possesses welfare interests, reflective normative capacities, or standing to contest rules require separate philosophical and empirical arguments. As de Ruiter’s critique of the relational turn toward moral status illustrates, social responsiveness alone can leave moral-status inferences underdetermined [39]. GR inquiry may remain receptive to revised understandings of artificial subjects without assigning such standing by terminological stipulation.

3.6 Comparative Diagnostics for Relational Histories

A disciplined comparison requires an evidence register that names the observed task, identifies the participant whose output is assessed, and traces the institutional and material relations that sustain the activity. Table 2 presents a provisional diagnostic scheme. The entries are questions for inquiry, and their answers may be incomplete, contested, or historically variable. They are intended to make the comparison sensitive to power while avoiding a claim that all forms of dependence can be reduced to one numerical index.

The register is intentionally asymmetrical. Human experience, labor protections, or legal remedies cannot be mapped one-to-one onto model parameters and service permissions. Conversely, traceable model-version histories or formally specified execution limits may have forms of documentation that differ from evidence of human learning and judgment. The comparison aims to reveal which relations can be described at a common analytical level and which dimensions require distinct methods of inquiry. Where an investigation concerns the social position of the firms that deploy AI, the provider should also be analyzed as a human organization with contractual obligations and political influence; its position cannot be inferred from the model’s output properties alone.

Several discriminating observations follow. Two services producing equivalent outputs may be differently dependent on particular providers or data sources. Two workers performing similar tasks may experience different degrees of bargaining power and institutional recognition. A change in the apparent autonomy of a service may be caused by an interface update without a corresponding change in its technical model, or by a model update without a change in the contractual authority of its provider. A measurable redistribution of control over maintenance, access, or rule revision would support a claim about political-economic transformation more directly than an increase in performance alone. Conversely, if the relevant relations remain unchanged across systems and settings, the proposed GR descriptors may contribute little beyond established organizational and labor analysis. Their explanatory value should be tested comparatively.

3.7 Implications for Heterogeneous Political-Economic Comparison

Behavioral similarity creates occasions for substitution, cooperation, complementarity, and comparison. Its consequences depend partly on the relational histories and institutional arrangements within which these activities occur. The political-economic inquiry developed here therefore treats performance as one evidential layer within a broader analysis of how practical capacities are formed, maintained, represented, allocated, and governed. The perspective applies most directly to contemporary human–AI production, where many of the relevant arrangements are observable in organizations, contracts, labor processes, and technical documentation. Comparisons with other living systems or hypothetical future artificial subjects would require additional concepts suited to their distinctive conditions of existence and normative evaluation.

The specific GR proposal is modest. It asks whether historically reconstructed differences in generative conditions can explain variations in dependence, control, claims to value, and contestability among participants whose outputs appear similar. It proposes that apparent equivalence may coexist with politically significant differences in authority and exposure. These are conditions for research, not an established universal relationship between output similarity and power asymmetry. The next sections examine the productive and reproductive conditions themselves, the formation of relational capability and power, and the circulation of heterogeneous value. In that progression, performance comparison remains useful, while the investigation extends to the conditions through which distinct kinds of participants retain or lose practical possibilities.

4 Production and Reproduction of Generative Conditions

The political-economic analysis of heterogeneous generative-relational (GR) subjects requires an account of the conditions through which activities are sustained, renewed, and made available for further transformation. This section specifies that account across human labor, artificial-intelligence services, and social-ecological systems. It draws on social-reproduction theory, infrastructure studies, and sustainability scholarship to distinguish productive activity from the maintenance and renewal of its enabling conditions. A comparative register then connects the location of these conditions to the distribution of maintenance burdens, discretionary control, and exposure to interruption. The proposed GR contribution is a framework for comparing these relationships while preserving differences in embodiment, agency, institutions, and evidential access. The present analysis is conceptual and historically situated; its categories serve as research instruments and carry no claim to an exhaustive ontology of production.

4.1 Productive Activity and the Conditions of Its Continuation

A productive activity can be described through its immediate organization: who or what undertakes it, which resources are used, and what changes result. Its continuation raises a connected set of questions concerning the replenishment of capacities, the repair of resources, the integrity of supporting institutions, and the viability of surrounding conditions. A completed research report, an AI-generated translation, and a successful agricultural harvest may each be observed as outputs. Yet the relations that allow comparable activities to occur again are different, and they may extend far beyond the setting where an output becomes visible. These relations are integral to political-economic explanation whenever their control, depletion, or interruption changes participants' practical opportunities.

For the limited purposes of this section, *productive conditions* designate the resources and organizational relationships enabling a specified activity. *Reproductive conditions* designate the processes through which those resources, relationships, and relevant capacities remain viable or are renewed across an analytical interval. These are relational descriptions: the same arrangement may support production for one participant while constituting maintenance work for another. A computing facility is part of the infrastructure of an AI service, an employer and workplace for human workers, and a purchaser of electricity, water, equipment, and services supplied through other organizations. Classification depends

on the question and unit of analysis. Reproduction also varies in form: daily operation, repair after disruption, replacement of components, education of new practitioners, ecological regeneration, and institutional succession are analytically related yet materially distinct processes.

This differentiation follows established scholarship. Fraser’s analysis of capitalism’s background conditions emphasizes relations of social reproduction and political power that support activities typically classified as economic production [16, 17]. Star’s infrastructural perspective similarly directs attention toward work and arrangements that often become visible through breakdown, transition, or exclusion [45]. These antecedents already motivate an expanded account of productive conditions. The GR proposal seeks a more explicit comparison across heterogeneous participants: it asks which of their available practices depend on which enabling arrangements, how those arrangements are reproduced, and how changes to them redistribute feasible opportunities. A taxonomy of dependencies is useful to the extent that it improves historical reconstruction, institutional explanation, or empirical comparison.

The relevant conditions can be described in several registers. Some are immediately consumable inputs, such as electricity supplied to a particular computation. Others involve durable but depreciating means of activity, such as a building, trained skill, or production apparatus. Still others are relational and procedural: access permissions, community support, professional recognition, emergency maintenance arrangements, or accepted standards for exchanging evidence. A participant’s continued capacity may rely on all three registers. Their interactions complicate attempts to infer long-term viability from a single performance measurement, asset valuation, or operating-cost estimate. They also require care in identifying whether an apparent capacity loss concerns the participant’s own capacities, restrictions on its access, or disruption of a wider support network.

4.2 Social Reproduction and the Maintenance of Human Capacities

Human productive activity is sustained through biological, interpersonal, educational, and institutional conditions that differ by life course and social position. Food, rest, shelter, health services, personal relationships, education, and care can enable individuals to maintain and develop capabilities for work and broader forms of practice. The distribution of responsibilities for such conditions is historically organized through households, employers, public services, communities, and markets. Social-reproduction theory has long investigated the relations between paid production and activities of care and daily or intergenerational renewal [5, 17]. The International Labour Organization’s assessment of paid and unpaid care documents why the allocation and recognition of care responsibilities are also matters of labor policy and inequality [2].

Consider a researcher who produces analyses with the assistance of a digital platform. The immediate research activity may depend on technical competence and access to datasets. Its continuation may also depend on a stable livelihood, sustained time for inquiry, professional collaboration, educational resources, and opportunities for restorative care. Employment and research-funding arrangements can enable inquiry while imposing reporting obligations or concentrating discretion over the subjects, methods, and timing of research. These effects vary among institutions and contracts; their analysis requires evidence about actual conditions rather than an inference from the researcher’s output alone. The researcher’s ability to change research direction, refuse a task, or continue working during service interruption can be influenced by these broader arrangements.

The concept of reproduction carries an additional political-economic implication: costs of productive continuity may be allocated outside the institution that receives or accounts for the output. Unpaid household labor, informal assistance, or publicly funded education can support activities rewarded elsewhere. Such transfers do not have a single normative meaning. Family care may express affection and mutual obligation, public education may be supported by democratically enacted institutions, and unpaid work can also reflect substantial asymmetries in bargaining power or exposure. The analytical question is how these activities support specific capacities, who bears the associated effort and risk, and who participates in decisions concerning their distribution. Determining exploitation or injustice calls for further historical and normative argument, including attention to consent, feasible alternatives, and institutional

entitlements.

Human reproduction includes intergenerational transmission of skills, language, practices, and shared resources. These processes can both preserve inherited capacities and make new kinds of activity possible. Consequently, productive continuity should not be interpreted as mere duplication of an unchanged worker or standardized output. Education, social learning, professional organization, and collective inquiry can expand or redirect possible practices. At the same time, sustained care and resource provision remain necessary even where observable productivity improves. A future study could investigate whether the allocation of reproductive burdens influences the range of research, occupational, and collective practices that participants can realistically pursue. Such a study would need independent measures of those practices and of the institutional conditions affecting their availability.

4.3 Artificial Production and the Reproduction of Digital Infrastructures

A deployed AI service depends on conditions markedly different from those of a living human researcher. Its continued operation may require functioning processors, electricity, communications infrastructure, data storage, system maintenance, software dependencies, security updates, and access arrangements maintained by one or more organizations. Particular services may additionally depend on external tools, retrieval systems, human evaluation, technical support, and ongoing service contracts. A model’s trained parameters, a running application, and the organization operating the application are distinct analytical objects. A copy of a model may remain stored while a deployed service becomes unavailable; conversely, operators may preserve service availability through replacement or modification of the underlying model. Continuity of an application, persistence of an artifact, and the introduction of new model capabilities therefore require different evidence.

The International Energy Agency’s *Energy and AI* report documents the material importance of electricity supply for data centers and models possible changes in demand [24]. These data-center analyses cover a broader technological category than AI alone. UN Trade and Development’s *Digital Economy Report 2024* similarly situates digital infrastructures within supply chains for raw materials, energy, water, equipment production, and waste management, while emphasizing the uneven geographical distribution of environmental and economic burdens [50]. Such work substantiates the general point that apparently virtual services rely on geographically and institutionally distributed material arrangements. It does not, by itself, establish the resource footprint of a particular model or the distribution of environmental responsibility in a particular community. Those questions require service-specific inventory, operational measurement, and appropriately bounded life-cycle analysis.

The reproductive work of digital infrastructure also involves people. Engineers replace failed components, data workers curate and evaluate resources, staff respond to incidents, and operators revise permissions or policies. Such labor may occur through subcontracting or geographically dispersed supply chains; existing work on the hidden labor of commercial computing gives reasons to investigate its visibility and remuneration [20, 9]. A service description organized only around model capability can obscure these activities. Equally, attention to physical infrastructure should preserve the institutional differences between the people undertaking maintenance and the firms that own assets, contract for services, or impose operating policies. Their respective discretion, responsibility, and exposure cannot be attributed to the AI model simply because the model is the visible interface to the service.

Different modes of continuity carry different implications for the term *reproduction*. Maintaining a running inference service may preserve a given configuration. Updating a model or its surrounding software may transform permitted actions or observed behavior. Replicating model weights may create an additional technical copy while retaining dependence on licensed software, specialized compute, data access, or a provider’s hosting arrangements. Training a new system may reproduce organizational capabilities while yielding substantially different model behavior. These distinctions matter where continuity, redundancy, or substitutability is invoked to justify claims about the autonomy of a participant. The ability to produce multiple copies of a digital artifact can coexist with concentrated control over the practical conditions under which those copies can be operated.

A GR comparison can therefore treat an AI deployment as an object of relational dependence without treating its operation as biological self-maintenance or presupposing its subjective interests. For a current service, the primary politically accountable actors often remain the human organizations and individuals establishing and operating these relations. In more speculative future settings, artificial systems might undertake a larger share of maintenance, infrastructure repair, or the organization of resources. The resulting distribution of actual discretion would remain an empirical and institutional question. The descriptive analysis of changing capabilities cannot settle the philosophical or legal standing of the artificial system.

4.4 Ecological Renewal and Cross-System Dependence

Economic production is situated within ecological processes that sustain, transform, and sometimes limit available resources. Water cycles, soil formation, nutrient exchange, species interactions, and climatic conditions have different characteristic dynamics and spatial extents. They may support human activities and artificial infrastructures while being affected by those activities. Social-ecological resilience scholarship explicitly treats economic and social systems as embedded in, and interacting with, the biosphere [15]. This research provides a substantive basis for examining ecological conditions as part of production and reproduction, while retaining the disciplinary differences between ecosystem science and political economy.

An agricultural enterprise, for example, may maintain profitability through equipment, purchased inputs, labor, and contractual access to land. Its continued practical range can also depend on soil condition, water availability, pollination relationships, and the maintenance of neighboring ecosystems. Changes to one condition may be buffered or amplified by others. A locally increased yield does not alone establish the long-term renewal of the ecological conditions supporting cultivation. Conversely, a landscape restoration programme may involve near-term changes to production practices while aiming to expand future ecological or economic possibilities. Whether such a programme succeeds depends on locally specified measurements and causal evidence, including possible unintended ecological and distributive effects.

The analysis of nonhuman life requires a distinction between an ecological dependency and a political claim made on behalf of affected organisms. An organism may depend on a habitat without possessing the discursive capacity ordinarily assumed by human deliberative institutions. Ecological observation can inform claims about habitat viability, reproduction, mortality, and species interaction; translating those observations into institutional protection, compensation, or representation involves additional normative judgment. Multispecies approaches to structural injustice have argued for taking these relations seriously within political analysis [30]. A heterogeneous GR political economy can use this concern to examine which actors control habitats and ecological infrastructure, which organisms or communities bear disruption, and how ecological evidence enters decision making. It should leave open disputes about the appropriate form of representation and the moral significance of different life forms.

This register also reveals that *renewal* is not a uniformly positive descriptor. Some ecological dynamics sustain biodiversity while others can propagate invasive species, pathogens, or destructive disturbance. Likewise, the maintenance of a socially organized production system can perpetuate arrangements that participants contest. The evaluation of reproduction depends on what is reproduced, for whom, under which constraints, and with what effects on other systems. A political-economic vocabulary of generativity remains useful only when it permits such adverse or conflicting processes to be described without automatically classifying every expanded capacity as desirable.

4.5 Temporal Dependence, Deferred Maintenance, and Displaced Burdens

Productive activity and the renewal of its conditions may occur over different durations and institutional accounting intervals. A service contract can record immediate delivery while excluding costs for equipment replacement, environmental remediation, occupational health, or the education of future specialists. A manufacturing process may draw on resources whose restoration requires longer or less predictable

ecological dynamics. These differences are empirically and institutionally significant even where the analytical model uses a common time coordinate. They require an account of observed maintenance cycles and expected delays, rather than the assumption of one universal productive rhythm.

One candidate diagnostic is the distance between the party receiving benefits from an activity and the party responsible for maintaining its enabling conditions. The distance may be organizational, geographical, juridical, or informational. A digital service user may pay an identifiable subscription fee while the service's full material provision involves electricity networks, equipment manufacturing, mining, repair, and waste treatment distributed across jurisdictions. UNCTAD's analysis of the material footprint of digitalization provides an empirical motivation for investigating such distributed burdens [50]. The existence of a spatial separation does not itself prove unjust transfer. It indicates where evidence about costs, contractual obligations, risks, and affected communities should be assembled.

Another candidate diagnostic concerns *maintenance deferral*: an arrangement continues to produce visible outputs while postponed repair or depleted resources progressively constrain later activities. Deferred maintenance can occur in public infrastructure, technical systems, professional training, and ecological management, though the mechanisms and measurements differ. A deterioration in service reliability, unremedied workplace hazards, or declining ecological function may serve as relevant indicators within particular cases. For many systems, however, delayed consequences and substitution pathways are uncertain; historical reconstruction and longitudinal analysis are necessary to assess the mechanisms involved. The causal effects of a specific deferral cannot be inferred from an appealing cross-domain analogy.

Reproductive arrangements also contain paths for learning and change. Workers may develop collective skills and governance mechanisms, operators may redesign an energy-intensive service, and communities may revise land-use practices. These responses can alter the organization of both production and maintenance. Their availability may depend on access to information, ownership, bargaining rights, legal permissions, and capacities for coordination. A further question is whether those affected by deterioration can participate in defining the relevant indicators and in deciding whose losses receive recognition. The present section identifies these issues as political-economic dimensions of reproduction; the analysis of effective power and legitimate authority is developed in subsequent sections.

4.6 Maintenance Access, Substitution, and Institutional Discretion

Dependence on an enabling condition becomes politically consequential through the institutions and relationships that govern its provision. A condition may be shared and collectively governed, supplied competitively, contracted under exclusive terms, or made accessible through a centrally controlled technical interface. Each configuration can sustain productive activity. Their implications for autonomy depend on the ability to repair, substitute, negotiate, or challenge interruptions, and on the costs borne by those pursuing such responses. An arrangement providing highly reliable support may expand participants' immediate capacity while also concentrating the discretion to change its terms. The two observations are compatible and require separate evaluation.

Substitution is especially important. A researcher who loses access to a particular AI service may retain the ability to continue through local software, other services, colleagues, or non-automated methods, but the alternatives may require additional funding, expertise, time, or changes to institutional permission. A community reliant on one water source may face physical and legal constraints distinct from those of a service subscriber. An ecological organism's feasible alternatives may be limited by habitat fragmentation, physiological requirements, or mobility. These examples illustrate differing meanings of exit and adaptation; they provide no basis for collapsing them into a universal index of freedom. Evidence of actual alternatives should be gathered at the relevant level of analysis.

Institutional reliability is also a form of productive support. Common-resource institutions, for example, can establish procedures for monitoring, maintenance, contribution, and conflict resolution [35, 36]. In some circumstances, collective provision can reduce risks associated with single-provider dependence. In others, public or cooperative institutions may themselves struggle with resources, inclusion, or

accountability. The empirical comparison should consider maintenance capacity, the distribution of decision rights, accessibility of alternative providers or techniques, and the ability of affected participants to contest operating decisions. The GR framing adds a question about the continuing range of feasible practices under each arrangement, with the understanding that feasibility is locally specified and only partially observable.

Reproduction can therefore be studied as a relation of provision and discretion: who contributes to maintaining conditions, who can authorize or interrupt access, who absorbs losses during breakdown, and which mechanisms permit repair or institutional revision. These dimensions may change independently. An organization may retain ownership while delegating technical maintenance; a worker may gain access to better tools without gaining authority to revise occupational rules; a community may gain ecological restoration funding while remaining excluded from land-use decisions. Such differences caution against the automatic identification of productive expansion with political autonomy. They also make possible comparisons of institutional reforms that improve continuation, distribution, and accountability in different combinations.

4.7 Comparative Register of Reproductive Conditions

Table 3 assembles the proposed comparison across several kinds of participant or arrangement. It is a diagnostic register, not a claim that these participants undergo equivalent reproductive processes. Its rows identify candidate conditions and forms of evidence; further causal inquiry is necessary to evaluate any particular relationship. In particular, the table avoids attributing biological needs, experience, or moral interests to present AI services.

Table 3: Comparative register of generative conditions, renewal processes, and interruption evidence across heterogeneous arrangements.

Arrangement	Enabling conditions	Renewal and maintenance	Possible interruption evidence
Human research activity	Livelihood, health, training, institutional access	Care, learning, compensation, collaboration	Attrition, restricted access, loss of available research practices
AI service deployment	Compute, electricity, software, networks, operations	Hardware repair, updates, staff support, service contracts	Outages, access withdrawal, degraded service continuity
Digital supply chain	Materials, skilled labor, energy, contracts	Replacement, recycling, logistics, labor reproduction	Supply interruption, unremediated impacts, maintenance backlog
Agricultural system	Soil, water, organisms, labor, land access	Ecological cycling, stewardship, cultivation, repair	Soil degradation, disrupted water supply, reduced viable practices
Shared civic infrastructure	Physical assets, funding, public rules, expertise	Maintenance budgets, collective governance, succession	Service failures, exclusion, loss of institutional capacity

The register also exposes a methodological challenge: the appropriate outcome measure depends on the arrangement. Service uptime, labor-force retention, ecological condition, and continued participation are not interchangeable metrics. Comparisons may nevertheless reveal recurring institutional patterns, such as concentrated control of maintenance interfaces, burdens carried by less visible contributors, or limited alternatives when access is interrupted. Researchers can test such patterns through contracts and governance records, labor and time-use studies, engineering maintenance logs, service inventories, ecological monitoring, and interviews with affected participants. The explanatory advantage of GR categories would have to appear in those comparisons, for example through improved identification of neglected reproductive dependencies or differences in practical alternatives that conventional measures fail to capture.

The section has thus specified *generative conditions* as a provisional relational research object grounded in practices of provision, repair, renewal, and institutional organization. Human social reproduction, digital service maintenance, and ecological regeneration share politically consequential relations of dependence while retaining distinct mechanisms, evidential requirements, and normative implications. The analysis points to a further question: when participants depend on conditions maintained by others, how do unequal capabilities and institutional permissions shape the power to alter, withhold, or redistribute those conditions? The account establishes terms needed to approach that question while distinguishing technical capability, effective control, and legitimate authority.

5 Relational Capability and the Formation of Power Asymmetries

The political-economic significance of generative conditions depends partly on how participants can access, maintain, negotiate, and alter them. This section examines the formation of power asymmetries among heterogeneous generative-relational (GR) subjects by distinguishing capacities to act from discretionary control over the conditions of another participant's activity. The inquiry begins with relational dependence and proceeds through outside options, bargaining, structural control, and the distribution of authority among human and artificial systems. It then specifies comparative evidence and normative limits. The argument is an analytical extension of established theories of power and political economy, especially power-dependence relations, exit and voice, structural power, and non-domination. Its proposed GR contribution lies in comparing how control over heterogeneous *generative conditions* can shape the range of practices available to differently constituted participants. This comparison requires locally defined outcome domains and does not presuppose equivalent kinds of agency, moral standing, or welfare.

5.1 Relational Dependence as a Condition of Effective Power

A participant's productive capacity describes what it can accomplish under specified enabling conditions. A power relation concerns what one participant can induce, obstruct, permit, or change in the practical situation of another. The distinction matters whenever impressive technical ability coexists with limited control over the infrastructure that supports its exercise. A research worker may have advanced methodological expertise while remaining dependent on an employer's access permissions. An AI service may perform an extensive set of tasks while relying on remote computation, deployment policies, and human operators. A utility provider may have comparatively modest expertise in a customer's specialized work while exercising consequential control over a necessary input. In each case, capacity and effective power must be evaluated with respect to the specific relation under investigation.

Emerson's classic account of power-dependence relations treats power as a property of a relation between actors and connects dependence with the availability and significance of alternatives [13]. His formulation provides a direct antecedent for the present argument; relationally situated power is an established idea rather than a discovery attributable to GR. A proposed extension becomes useful when different actors' relevant conditions include heterogeneous resources, knowledge systems, ecological requirements, or institutional permissions. The strength of a dependence cannot be established solely by comparing the parties' general wealth, intelligence, output quality, or computational performance. It also depends on what the dependent participant seeks to do, what disruption would entail, which substitutes are available, and which arrangements allow a claim or objection to be heard.

Dependence is frequently reciprocal yet asymmetrical. A service provider relies on users, employees, investors, network operators, and public institutions, while individual users may depend on that provider to complete a particular task. The provider's need for an aggregate customer base does not establish symmetrical bargaining power with any single customer. Likewise, a large institution may depend on skilled personnel collectively while individual workers face high costs of changing employers. The level at which participants are aggregated—an individual, organization, community, technical subsystem, or

supply chain—therefore changes the observed dependence relation. An analysis that treats “AI,” “humanity,” or “the platform” as internally homogeneous would obscure many of these differences.

The present use of *relational capability* denotes the context-dependent ability of a participant to maintain or change a specified range of practices through its own actions and available relationships. This is an analytical descriptor of a position in an organized setting. It does not imply that every entity classified as a GR participant forms intentions or holds normative commitments. A human worker’s exercise of relational capability, a corporation’s legal discretion, and a software component’s permitted operations require distinct forms of attribution. For a deployed AI system, the relevant question may concern effective technical permissions and externally controlled activation, rather than an independently held political entitlement. The classification must remain sensitive to whether the purported actor is a person, a collective institution, or a technical component of a larger organization.

5.2 Outside Options, Substitutability, and Bargaining Conditions

The availability of alternatives helps explain how dependence becomes bargaining leverage. An outside option is a feasible course of activity available if an existing relationship changes or ends. Its practical value depends on transition costs, time, legal restrictions, knowledge, maintenance requirements, and the possibility of retaining other important relationships. Two nominally competing AI services may provide similar functions, yet their practical substitutability for a particular researcher can differ because of data-portability rules, domain-specific interfaces, archived workflows, or institutional procurement contracts. Counting suppliers without tracing these conditions may give a misleading description of available choice.

Hirschman’s distinction among exit, voice, and loyalty offers a foundational analysis of responses to dissatisfaction within organizations [22]. Exit may be exercised through changing an employer, product, or institutional affiliation. Voice may involve requesting a rule change, challenging a decision, or organizing with other affected participants. Their feasibility and effectiveness often differ; an inexpensive exit option may reduce one dependency while leaving another form of exclusion intact. Loyalty can influence continued participation and opportunities for collective repair. The present comparison extends these familiar ideas to technical interfaces and heterogeneous conditions, while recognizing that established human political and organizational rights cannot automatically be assigned to present AI services or to nonhuman organisms.

Substitution also has a relational price that is not captured by immediate monetary expenditure. Moving to another cloud platform may require retraining staff, revising security procedures, losing accumulated integration work, and obtaining new permission to process protected data. Changing a workplace may disrupt professional communities and care arrangements. Relocating a population of organisms to a different habitat may introduce ecological and physiological constraints that lack any sensible translation into a consumer switching cost. These examples share an analytical concern with foreclosed or expensive alternatives, but they differ in causal mechanism, normative significance, and research method.

Power asymmetry can persist even when the dependent participant receives substantial benefits from the relationship. A reliable proprietary infrastructure may expand productive capacity while keeping the right to change prices, revoke access, or alter technical conditions concentrated in one organization. Whether this arrangement is exploitative, justifiable, or beneficial under a given evaluative framework requires further evidence about distribution, agreement, alternatives, public obligations, and affected parties. In particular, a comparison of actual outcomes under a service relationship with outcomes under immediate termination may overlook feasible institutional arrangements that were never offered. Appropriate counterfactual analysis must therefore consider credible alternatives, not merely current continuation versus complete withdrawal.

5.3 Discretion over Access, Maintenance, and Rule Revision

Power over generative conditions can take the form of discretion to supply, interrupt, redesign, or condition access. The relevant decisions may concern electricity, medical care, scientific data, software

updates, physical territory, network connectivity, professional accreditation, or the enforcement of contracts. An organization may possess the ability to interrupt an activity without ordinarily exercising that ability. A routine service outage, a legally required safety restriction, and a discretionary withdrawal of access can produce superficially similar effects while reflecting different mechanisms and institutional justifications. A political-economic account should therefore record both the technically feasible intervention and the authority under which it may be undertaken.

In established political theory, Pettit's account of non-domination gives particular importance to the capacity for arbitrary interference, including cases without observed interference [37]. This account provides a normative perspective on dependence, although its application to corporations, ecosystems, and AI systems is not automatic. For the present analysis, it motivates an empirical distinction between actual interruption, credible discretionary power to interrupt, and mechanisms that make such discretion accountable. A long uninterrupted service history can coexist with concentrated control over the conditions for future continuation. Conversely, interruptions undertaken under transparent safety rules and contestable public procedures need to be evaluated differently from unilateral, opaque decisions; the reason for an intervention matters alongside its observable effect.

Discretion is also distributed across organizational layers. Consider a research assistant that makes use of a hosted AI model. The service provider may control model access and updates, the cloud operator may control physical infrastructure, the research institution may govern permissible datasets, the worker may choose tasks within contractual boundaries, and public authorities may impose privacy or safety obligations. None of these participants necessarily possesses complete control over the observed workflow. Yet particular decisions may create localized bottlenecks through which one organization can substantially redirect another's activity. The inquiry requires tracing decisions and permissions through the chain rather than attributing all resulting outcomes to either "the AI" or "the human user." Existing work on platform-based economic organization and computing governance supplies important background for such tracing [43, 40].

A further distinction concerns rights to propose, approve, implement, and contest changes. An interface may let users request a rule alteration while retaining unilateral approval and implementation rights for an operator. Workers may participate in consultation without acquiring bargaining or veto rights. A conservation body may invite local testimony while fixing the categories through which testimony is assessed. These arrangements distribute voice and discretion differently. They also illustrate why the existence of a participatory channel cannot itself establish that participants have effective influence. Evidence should include the disposition of proposals, transparent reasons for rejection, avenues of appeal, and the practical consequences of challenging a decision.

5.4 Structural Power and the Organization of Available Choices

Direct bargaining is only one setting in which power operates. A participant may influence outcomes by determining which resources, standards, classifications, and relationships are available to other participants in the first place. Strange's treatment of structural power in international political economy offers an established account of how economic and political structures shape others' possibilities [46]. Lukes's multidimensional analysis similarly emphasizes decision-making, exclusion of issues from collective deliberation, and the shaping of what actors understand as possible or desirable [29]. These contributions already complicate interpretations that equate power with overt coercion. The present GR account draws on them when examining the conditions under which diverse participants can develop, sustain, and transform their activities.

A technical standard may make some kinds of output visible while excluding others. An institutional eligibility rule can determine which contributions are recognized as labor or expertise. A platform interface can constrain the set of permissible actions before any individual user makes a choice. These arrangements can facilitate coordination, ensure safety, and make systems interoperable, while also distributing burdens and discretion. The political-economic task is to identify who can revise the standard, whose practices it accommodates, how affected parties encounter its constraints, and which alternatives

would be practicable. This structural analysis connects with scholarship on classification and infrastructure without replacing the domain-specific explanation of those systems [6, 45].

For heterogeneous subjects, structural power can have a particularly important interpretive component. Different participants may lack a shared vocabulary for describing their activities, dependencies, and perceived injuries. Institutions that determine the categories of observation and evaluation can therefore affect which forms of contribution or harm become legible. One cannot infer deliberate domination from every failure of translation or classification; incomplete information, technical constraints, and conflicting obligations may generate similar observations. Nonetheless, asymmetrical control over the interpretive interface is a legitimate object of investigation. The later analysis of norm-making authority will address the mechanisms of interpretation in greater detail, while this section considers the economic consequences of control over access to recognition and remedies.

The relational framing also makes cumulative dependencies visible. A group may acquire a new productive capability through a powerful intermediary, reorganize its practices around that intermediary, and thereby face higher later costs of transition. Such a sequence is a possible mechanism of path-dependent dependence, not a universal result of technological adoption. It should be tested through longitudinal evidence concerning investment, training, interoperability, bargaining terms, and institutional alternatives. A platform may also reduce transaction costs, broaden access, or help sustain smaller participants. The balance of these effects must remain an empirical question, and apparent productivity gains should be assessed separately from the redistribution of discretionary power.

5.5 Human–AI Power Relations across Organizational Positions

Human–AI political-economic relations supply a contemporary setting in which the distinction between performance and authority can be studied concretely. A deployed model may generate scientific hypotheses, summarize legal documents, or carry out portions of an engineering workflow. These performances involve technical capacities that are relevant to production. They also depend on human labor, training processes, data acquisition, chips, energy supply, software maintenance, distribution channels, and institutional governance. The actor able to generate an output through a model may have little authority over the model’s maintenance conditions, while the organization controlling those conditions may not possess the user’s specialized expertise.

Several power relations intersect. Workers involved in data preparation and evaluation may have limited influence over product design and deployment despite contributing to model reliability. Service users may gain access to previously unaffordable analytical capabilities while accepting changing prices and access rules. Independent developers may depend on a small number of model or compute suppliers. Firms supplying technical infrastructure may depend on labor markets, utilities, capital, public licensing, and downstream demand. Governments can affect some of these conditions through regulation and procurement while remaining reliant on private technical expertise. These relationships are not adequately represented as a single bilateral contest between “humans” and “AI.” Materially relevant power often lies among human and corporate organizations that own, operate, finance, maintain, or regulate AI systems [9, 20].

The potential political-economic position of a more autonomous artificial participant requires an additional, explicitly conditional analysis. If an artificial system were to develop capacities for durable commitments, independent acquisition of resources, or governance of its own operating conditions, researchers would need to examine the resulting relationships without assuming that its outwardly persuasive speech proves subjective experience or moral entitlement. At present, the permissions of a deployed AI agent are typically configured within an institutional and technical arrangement. Observable abilities to issue requests, call tools, or generate plans must be distinguished from legal ownership and the enforceable right to amend those permissions. Questions of independent artificial normative agency and status remain open, and conclusions should follow the specific evidence and legal contexts available.

A narrow comparison can clarify the analytical stakes. Suppose a human researcher and an AI-based research service both produce a reliable literature synthesis. The human researcher’s ability to continue

may be conditioned by employment, income, health, scholarly networks, and access to materials. The deployed service’s continuation may turn on subscription status, compute allocation, model availability, and data permissions set by several organizations. The similar output establishes task-relative performance adequacy. It does not identify which participants control the respective reproductive conditions, who can authorize changes, or who bears risks when a workflow is interrupted. Comparative explanation requires the latter observations. The value of the GR descriptor would be demonstrated if it enabled researchers to find power-relevant differences that a performance-only analysis overlooked, while identifying cases where established organizational analysis already suffices.

5.6 Comparative Evidence for Power over Generative Conditions

The comparison developed in this section can be organized around several observational questions. For any specified activity, researchers should identify the relevant enabling conditions; distinguish those contributing to maintenance from those exercising discretion; document available substitutes; examine procedures for challenge and revision; and establish which interventions actually change the participant’s feasible practices. Table 4 presents a preliminary register. Its rows are relational arrangements rather than claims that the listed participants possess equivalent intentions, rights, or capacities.

Table 4: Diagnostic register for relational capability and power asymmetries across selected productive arrangements.

Arrangement	Relevant dependency	Possible locus of discretion	Evidence for alternatives or contestation
Researcher and institution	Income, infrastructure, credentials, access	Employer, funder, archive administrator	Mobility, contracts, grievance processes, independent facilities
AI-service user and provider	Model access, data portability, uptime	Developer, cloud operator, platform owner	Switching costs, export functions, terms changes, appeals
Independent AI developer and suppliers	Compute, model interfaces, components	Compute vendor, upstream model supplier	Interoperability, supplier alternatives, licensing restrictions
Community and shared infrastructure	Water, energy, transportation, maintenance	Utility or public governing body	Participation records, oversight, emergency alternatives
Ecological management arrangement	Habitat, land use, restoration resources	Landholder, regulator, management institution	Ecological monitoring, affected-group representation, review rules

The proposed register is deliberately qualitative. A quantity such as the percentage of resources supplied by one provider can describe concentration, but its interpretation depends on substitutability, vulnerability, and the ability to withstand interruption. Contractual rights may reveal formal discretion while leaving actual negotiating power uncertain. User satisfaction may coexist with an absence of credible exit options. Disparate measurements therefore require careful triangulation: governance documents, interviews, administrative data, engineering records, records of service interruption, and longitudinal changes following policy revisions can support different parts of the explanation.

Causal attribution requires additional care. A decline in research output following a loss of platform access may arise from lost capability, interrupted collaboration, contract uncertainty, or adaptation costs. Evidence of a price rise alone is insufficient to establish domination or exploitation. Where feasible, researchers could compare changes in access across similar organizations, document negotiated exceptions, or study staged transitions to alternate infrastructures. Suitable designs must address selection, hidden dependencies, and the possibility that actors change their behavior in anticipation of a threatened intervention. The present section identifies these comparisons as a research programme; it reports no new empirical measurement of human–AI dependence.

1094 5.7 Effective Power, Recognized Authority, and Political-Economic Evaluation

1095 The analysis yields three distinct questions. The first is whether one participant possesses a technical or
1096 institutional capacity to alter conditions on which another depends. The second is whether that capacity
1097 is exercised, threatened, delegated, or otherwise incorporated into expectations and decisions. The third
1098 is whether the resulting authority and its exercise are justified under the applicable legal and normative
1099 framework. An affirmative answer to the first provides no automatic answer to the third. Likewise, the
1100 observation of stable and beneficial cooperation does not by itself settle whose interests are recognized,
1101 whether dissent is possible, or which procedures should govern changes to the relationship.

1102 For human communities and institutions, considerations of consent, due process, non-domination,
1103 democratic participation, and distributive justice may provide competing or complementary grounds of
1104 evaluation [37, 36]. These considerations should be interpreted through actual legal and historical set-
1105 tings rather than posited as timeless standards accepted by every kind of possible subject. Ecological
1106 relationships may require welfare, stewardship, or conservation criteria suited to relevant forms of life.
1107 Deployed AI services can be evaluated through responsibility for design, labor conditions, human rights,
1108 market organization, and affected users without assuming the services themselves possess independent
1109 claims of moral personhood. In a hypothetical encounter with more technologically capable extrater-
1110 restrial agents, the same analytical distinctions would help identify claims to power, while the entities’
1111 capabilities, norms, and legal standing would remain speculative.

1112 A political economy of heterogeneous GR subjects can thus examine how asymmetries in access,
1113 maintenance, substitution, voice, and institutional discretion shape the continuation of different kinds of
1114 practice. The account inherits substantial foundations from established theories of relational and struc-
1115 tural power. Its further contribution remains conditional: it proposes that comparison across differently
1116 constituted participants may reveal forms of power that become obscure when productive capability is
1117 measured only by output or when an economic relationship is represented only by monetary exchange.
1118 This proposition requires further testing against existing frameworks, with particular attention to coun-
1119 terexamples in which strong dependence coexists with robust accountability and in which formal rights
1120 coexist with constrained practical alternatives. The following sections address heterogeneous value cir-
1121 culation and the institutional power to define, translate, and regulate the terms through which such value
1122 becomes recognizable.

1123 6 Heterogeneous Value Creation and Circulation

1124 Political-economic relations among heterogeneous generative-relational (GR) participants involve more
1125 than the production of outputs and the allocation of resources. They also involve the recognition of
1126 contributions, the conversion of one form of value into another, the organization of circulation, and the
1127 distribution of the capacities that make further production possible. This section develops a preliminary
1128 comparative vocabulary for these processes. It first distinguishes situated valuation from productive con-
1129 tribution, then examines generative circulation, value capture, conversion interfaces, human–AI arrange-
1130 ments, and ecological relationships. The final subsection proposes a protocol for tracing the relevant
1131 pathways empirically. The discussion draws on established work in political economy, economic soci-
1132 ology, value-chain governance, philosophy of value, and plural ecological valuation. The proposed GR
1133 extension concerns the comparison of value relations among differently constituted participants, while
1134 retaining uncertainty about whose evaluations count, which conversions are possible, and what grounds
1135 a justified distribution.

1136 6.1 Situated Valuation and the Identification of Productive Contributions

1137 *Value* can refer to several distinct objects of inquiry: the usefulness of an activity to a participant, a
1138 monetary amount realized in exchange, a collectively recognized contribution, an ethical appraisal, or
1139 a condition sustaining future activities. These senses overlap in some institutional settings and diverge

in others. A technical improvement may command a price, support public research without payment, reduce an ecological burden, or generate costs borne by people who do not participate in the associated market. A preliminary GR political economy therefore has to specify the relevant practice and valuation context whenever it attributes value to an output or relationship.

Lepak, Smith, and Taylor distinguish value creation and value capture across levels of analysis, including individuals, organizations, and society, and explicitly discuss use and exchange value [28]. This provides a useful antecedent for separating the production of something valuable from an actor's appropriation of its returns. A software tool might produce substantial use value for a research community while bringing little direct revenue to its original developer. Conversely, a firm might collect revenue from access to a service whose development relies on external research, user feedback, data work, and publicly financed infrastructure. These observations motivate attention to multiple participating institutions and contributors. They do not, by themselves, determine a just distribution of the resulting revenues.

The GR perspective proposed here treats valuation as situated in relations among a participant, the evaluated activity or condition, and a context of use, recognition, and institutional mediation. For comparison, it is useful to distinguish *contribution* from *recognized contribution*. A person may contribute labor to an outcome without receiving recognition, while a legal entity may receive revenue or ownership rights without having performed the corresponding physical or cognitive work itself. Such separations may follow contractual or institutional arrangements; their ethical evaluation depends on further evidence about authorization, obligations, alternatives, and the effects on those involved. For a deployed AI service, it is similarly important to distinguish the contribution of a computational process to an output from claims about the model's independent interests or entitlements. The former can be investigated operationally, while the latter require separate arguments.

The relevant unit of analysis consequently varies. A valuation may concern an individual worker, a research team, a platform, an ecosystem-management institution, or a population affected by an intervention. Aggregating these units may conceal losses and benefits that are distributed unequally. A finding that an AI-enabled organization creates substantial economic value, for example, leaves open how its revenue depends on training labor, energy, electricity networks, software maintenance, and the organizational decisions that govern access to the service. It also leaves open whether users obtain enduring independent capabilities or remain dependent on the provider's continuing operation. The study of value therefore connects directly to the generative conditions and power relations examined in Sections 4 and 5 only where the specified evidence allows those connections to be established.

6.2 Generative Circulation and the Renewal of Productive Conditions

The idea of generative circulation asks whether the value produced within a set of relationships can support further productive activity among the people or communities whose work, knowledge, or resources contribute to its creation. Eglash's account of *generative justice* is an important inspiration for approaching political economy through value creation and circulation. His historical argument gives particular attention to forms of bottom-up circulation that retain or return value to its generators [11]. The present inquiry acknowledges that contribution without treating the GR vocabulary, its comparative questions, or its possible formal representations as derived in their entirety from Eglash's theory.

Circulation may involve money, equipment, skills, education, public knowledge, infrastructure access, repair capacity, ecological regeneration, and institutional decision-making authority. These processes cannot automatically be converted into one another. When a community develops an open scientific instrument, for example, public access to design files may enlarge knowledge circulation. Local ability to manufacture, calibrate, and maintain the instrument may nevertheless depend on restricted parts, paid expertise, or distant fabrication facilities. A public design can therefore coexist with unequal access to the conditions needed to put it into practice. Such an arrangement would require a differentiated assessment of informational openness, material accessibility, and the renewal of productive capacities.

Three meanings of *return* deserve particular care. A contractual return allocates a specified payment or entitlement. A reproductive return maintains the capacities and relations on which an activity relies.

A political or normative return provides contributors or affected participants with opportunities to challenge, influence, or revise the rules governing the activity. These categories are proposed analytical distinctions; they need not travel together. A well-paid contractor may still lack a voice in how their data work is represented, while a participant in a cooperative may have strong governance rights but face persistent material insecurity. Similarly, licensing revenue could sustain a public-interest project or finance activities unrelated to the community that made the resource valuable. The location and magnitude of a financial flow alone cannot settle which capacities it reproduces.

A process of circulation can also remain *open-ended*. Productive knowledge may generate a new practice, whose conditions and contributors were absent from the original exchange. The creation of these opportunities is one reason for attending to generativity, yet it should not be counted automatically as a welfare gain. New activities can also increase environmental pressures, draw unpaid care work into new demands, or strengthen dependencies on proprietary infrastructures. Evaluating generative circulation therefore requires tracing the opportunities and obligations it creates, including those borne by participants who receive little of the measurable financial return.

6.3 Appropriation and the Governance of Conversion Interfaces

The political-economic distinction between value creation and capture becomes especially consequential when a contribution is converted into an institutional asset, market service, scientific credential, or enforceable claim. Gereffi, Humphrey, and Sturgeon's account of global value-chain governance shows how coordination and power asymmetry vary with transaction complexity, codifiability, and supplier capabilities [19]. Their framework offers an established vocabulary for analyzing intermediation, organizational dependence, and the distribution of control along production chains. The GR extension proposed here broadens the set of processes under examination to include epistemic and ecological contributions whose institutional valuation may differ from monetary valuation.

A *conversion interface* denotes an identifiable rule, technology, classification, or institutional procedure through which a contribution becomes legible and actionable in another domain. Examples include a pricing agreement, a dataset license, a research authorship policy, a procurement standard, a scientific evaluation rubric, a cloud-service contract, or a system that converts ecological monitoring records into a resource-management decision. These interfaces are heterogeneous. They may enable coordination and access, and they may also confer discretion over who receives recognition, payment, or permission to participate. Identifying an interface thus involves documenting its operation, the persons or institutions authorized to change it, the alternatives available to contributors, and the procedures through which decisions can be contested.

Conversion should be distinguished from appropriation. Translation of a research contribution into a marketable service may allow substantial additional productive activity without excluding the originating contributors. Under other arrangements, exclusivity terms, control of distribution channels, or technical lock-in may narrow their future options. A complete account needs to investigate the counterfactual opportunities available to those contributors as well as the resources required to maintain the downstream service. The mere observation of revenue capture does not establish exploitation; neither does a demonstrated downstream benefit establish that the distribution of value is legitimate.

A further complication concerns levels of attribution. An organization can collect subscription fees and pay wages while retaining legal authority over its models, customer relationships, and infrastructure. Within the same activity, different forms of value may accrue to users as time saved, to employees as income and experience, to investors as returns, and to the public as accessible knowledge or potentially as environmental burdens. The effects may be reciprocal without being symmetrical. This motivates a relational investigation of conversion interfaces that preserves the distinction between effective institutional control and the moral or political justification of its exercise.

6.4 Plural Valuation and the Boundaries of Translation

A single monetary metric can clarify certain exchanges and obscure other relations. Zelizer’s analysis of socially differentiated forms of money shows how monetary practices are shaped by earmarking, institutional restriction, and social meaning [52]. Anderson’s philosophical account of value pluralism similarly challenges the treatment of goods valued in different ways as if a market measure exhausted their significance [3]. These approaches supply established reasons to examine the context in which a conversion occurs and the social or normative claims it leaves unresolved.

In a provisional GR comparison, let $\mathcal{V}_i$ denote a locally specified domain of value descriptions available to participant or institution i . The domain may contain financial measures, rankings, publicly articulated claims, or qualitative categories, depending on the case. A translation between two domains may be recorded as a context-indexed relation $\mathcal{T}_{ij}^{(c)}$, defined in Equation 1.

$$\mathcal{T}_{ij}^{(c)} \subseteq \mathcal{V}_i \times \mathcal{V}_j. \quad (1)$$

The expression is a bookkeeping device for correspondences supported in context c . It represents neither a universal exchange rate nor a function that uniquely converts every valuation into another. A relation may contain several admissible correspondences for one description, and it may contain none for another. For example, a community may regard preservation of a culturally significant site as a requirement that remains relevant even when financial compensation is offered. Conversely, a monetary estimate may provide an actionable description of a particular maintenance cost without exhausting the reasons for protecting the site. The representation does not establish that every participant possesses an articulated valuation domain or that all value forms admit mathematical description. Empirical use would require operational definitions and evidence about the statements and practices by which the correspondence is recognized.

The IPBES assessment on the diverse values and valuation of nature provides a directly relevant methodological precedent: it documents multiple ways of conceptualizing and evaluating human relationships with nature and discusses their relevance for decision-making [27]. Plural valuation does not imply that every valuation is equally supported by evidence or normatively decisive. Some claims are factually mistaken, some trade-offs are legally constrained, and some choices require accountable decisions despite persistent disagreement. Its political-economic significance lies partly in how a decision process chooses which kinds of evidence and valuation can be presented, considered, or excluded.

Partial translation is therefore compatible with practical agreements. Different participants may coordinate around a habitat-restoration target while valuing the habitat for livelihood, biodiversity, historical responsibility, or religious reasons. Shared action would not demonstrate that these reasons had converged into one value. The opposite pattern is also possible: participants may use similar valuation language while assigning different practical priorities to maintenance, compensation, and authority. These variations call for evidence from institutional records, interviews, observed behavior, and material outcomes before a researcher infers normative agreement from the success of a transaction.

6.5 Human–AI Relations and the Distribution of Generated Value

Human–AI production provides a particularly revealing case because recognizable outputs can emerge from a distributed chain of contributors and infrastructure. Consider a researcher who employs an AI service to assist with coding, translation, and literature organization. A finished article may depend on the researcher’s domain judgment and verification, paid or unpaid contributions embodied in training materials, data annotators, hardware and energy providers, model developers, deployment operators, and institutional systems for reviewing scholarly outputs. The causal contribution and legal or institutional standing of these participants differ. One should therefore identify the relevant production process and actual agreements before assigning value shares or responsibilities.

Value can circulate along several pathways within the same arrangement. A user may receive a service and acquire reusable skills, while the provider receives payment and interaction data under the terms

of the service. A university may recognize the published result, while its reputation and reward systems determine which contributions become visible. Developers may improve models through separately authorized evaluation and maintenance. Data and feedback practices vary across services and governance regimes; the present discussion does not presume that a specific provider retains or uses every interaction for training. The political-economic question is which forms of contribution and benefit are permitted to circulate, which are restricted, and who can amend these conditions.

Recognizing the productive role of an AI component does not require attributing an independent claim to wages, authorship, consciousness, or moral rights. A deployed system may constitute a consequential participant in a technical production chain while its legal control and institutional obligations remain assigned to humans and organizations. Similarly, recognizing the material and intellectual contributions of people involved in model production need not imply that all contributors possess identical contractual entitlements. Those entitlements vary with applicable law and agreements, which must be examined within their jurisdictions. The GR approach can help expose where institutional categories map poorly onto distributed causal contribution, but the determination of rights and remedies requires a separate normative and legal analysis.

A salient outcome is *capability return*. An arrangement might offer immediate productivity gains while leaving the user unable to reproduce critical tasks once a subscription, network, or model permission is withdrawn. Another arrangement might enable skills transfer, local maintenance, and genuine exit alternatives. Neither outcome can be inferred from benchmark performance alone. Evidence would include changes in users' independent task competence, portability of their records and tools, switching costs, the distribution of maintenance work, and the enforceability of promised access. The contrast gives the GR vocabulary a potential comparative use: similar generated outputs may coexist with very different patterns of value circulation and the reproduction of generative conditions.

6.6 Ecological Contributions and the Allocation of Regenerative Burdens

Ecological systems complicate value circulation because their contribution to production is frequently mediated by human measurements and institutions, while the underlying processes involve organisms, habitats, and environmental dynamics with distinct conditions of persistence. A marine monitoring programme may deliver research data, employment, navigational information, and evidence useful for habitat protection. At the same time, its vessels, sensors, data centers, and maintenance operations require energy and materials and may affect local habitats. The presence of a valuable monitoring output is therefore compatible with substantial ecological costs, including costs displaced from the organizations that benefit most directly from the data.

For analytical purposes, it is useful to distinguish a contribution attributed to ecological processes, a human institution's valuation of that contribution, and the conditions enabling the ecological processes to continue. The distinctions are important because a price attached to ecosystem services can support practical accounting while leaving open cultural significance, ecosystem integrity, and obligations toward affected communities and nonhuman life. The IPBES plural-values assessment offers a more grounded basis for considering these differences than an assumed common metric of human, artificial, and nonhuman welfare [27]. The present analysis attributes neither human-like economic preferences nor explicit moral deliberation to all nonhuman organisms.

A return to ecological generative conditions may take the form of lower extraction pressure, habitat repair, continuing monitoring, accountable resource management, or support for communities whose work sustains conservation. Such interventions differ in their effects, beneficiaries, and evidential requirements. They can also create conflicts: a conservation measure may protect a habitat while constraining local livelihoods, and a new ecological technology may redistribute ecological burdens to distant mining or manufacturing sites. Treating ecological regeneration as a form of value return consequently remains a proposed analytic use; its justification requires local ecological evidence, affected-community participation, and explicit consideration of competing objectives.

This comparison also reveals a limit of the circulation metaphor. Some ecological processes are

Table 5: Comparative evidence for value circulation in human–AI knowledge production and ecological stewardship.

Analytical relation	Human–AI knowledge production	Ecological stewardship
Contribution	Work, data, research judgment, model operation, maintenance	Ecological processes, field labor, sensors, local knowledge
Recognition	Authorship records, contracts, documentation, evaluation criteria	Public valuations, ecological indicators, community testimony
Conversion interface	Platform terms, licenses, publication policies, service pricing	Management plans, reporting standards, budget procedures
Capture and allocation	Compensation, access restrictions, revenue, reusable skills	Project finance, livelihood effects, allocated responsibilities
Return to conditions	Portability, training, infrastructure access, repair capability	Habitat condition, local capacity, maintenance funding
Contestability	Appeals, audit access, withdrawal, rule revision	Participation, review procedures, monitoring and remedy

altered irreversibly at relevant human timescales; their effects cannot be represented faithfully as a commodity moving through a closed circuit. The term *circulation* is useful insofar as it directs attention to ongoing flows, dependencies, and institutional decisions. When considering ecological renewal, it must be supplemented by ecological thresholds, material balances, and assessments of how a practice changes future feasible conditions. The distinction helps prevent an appealing language of regenerative value from concealing measured degradation.

6.7 A Comparative Protocol for Tracing Value Circulation

A comparative inquiry can investigate heterogeneous value circulation without presuming universal commensurability by tracing a sequence of analytically distinct relations: productive contribution, recognition, conversion, allocation, and the effects of allocation on continuing capabilities. Table 5 identifies the types of evidence needed for two illustrative cases. The entries state research questions and possible observations; they are not empirical findings about any particular organization or project.

Such a protocol has at least three interpretive advantages. First, it distinguishes observed contributions from the institutional representations through which those contributions become valuable to particular decision-makers. Second, it allows value capture and value return to be studied independently: a system may distribute monetary revenues widely while concentrating control over essential infrastructure, or preserve public access while shifting maintenance costs to disadvantaged contributors. Third, it creates room for disconfirmation. If a conventional value-chain account fully explains a case, including observed control and reproduction outcomes, the additional GR vocabulary may yield little explanatory benefit. If variation in interpretive recognition and in the accessibility of reproductive conditions explains otherwise puzzling differences, the proposed comparative framework may warrant further development.

The main methodological challenge is to prevent the researcher from silently substituting one participant's valuation system for those of the others. Available evidence may support only partial attribution: researchers can document an organization's expenditure and a habitat's condition without establishing that the expenditure expresses a nonhuman participant's own preference. They can quantify a service's revenue without determining how much normative value users attribute to autonomy, privacy, or repair. The findings should therefore retain their domain and uncertainty, and comparison should preserve substantive conflicts that available data cannot resolve.

The political economy of heterogeneous GR subjects can accordingly study value through the organization of contribution, valuation, conversion, appropriation, circulation, and the continuing conditions of practice. These categories draw heavily on existing scholarship and are proposed here as a comparative interface across divergent human, artificial, and ecological arrangements. Their potential contribution depends on whether tracing such relations adds explanatory precision beyond established economic so-

ciology, institutional analysis, and value-chain research. The next section turns to interpretive infrastructures and norm-making authority, examining how the categories used to recognize and compare value are themselves produced, maintained, and made binding in unequal relations.

7 Interpretive Infrastructures and Norm-Making Authority

The political economy of heterogeneous generative-relational (GR) subjects includes the infrastructures through which activities become recognizable as contributions, risks, qualifications, or claims upon resources. An institution can alter the practical possibilities of a participant by deciding which observations count, which categories organize those observations, and which recorded differences trigger access, payment, supervision, or exclusion. This section examines the political-economic significance of such interpretive arrangements. It first specifies interpretive infrastructures and their relation to productive conditions, then analyzes classification, commensuration, standards, and auditing. It subsequently considers human–AI systems and ecological representations, distinguishes effective rule-setting from legitimate authority, and proposes comparative methods for tracing interpretive power. The argument is interpretive and institutional, with hypothetical examples used to clarify mechanisms. Its GR extension is a proposed comparison among differently constituted participants and the conditions under which their activity becomes actionable to others.

7.1 Classification and the Conditions of Institutional Legibility

An *interpretive infrastructure* is provisionally understood here as an organized set of categories, measurement practices, documentation systems, technical interfaces, personnel, and decision procedures through which some features of activity are represented and made available for institutional action. This definition encompasses an evaluation rubric, an occupational classification, a digital identity system, a dataset schema, or a standard governing the recognition of ecological conditions. The common feature is a durable relation between representation and decisions. A description prepared for personal reflection differs from a description that determines permission to work, compensation, access to a public service, or the eligibility of a research contribution for institutional recognition.

The importance of classifications for practical and institutional life is well established. Bowker and Star examine the historical development of categories and standards, showing how information infrastructures make some experiences and activities visible while obscuring others [6]. Star’s account of infrastructure likewise draws attention to the relational and often background character of systems on which coordinated work depends [45]. The preliminary GR question is more specific: how do these representational systems redistribute the possibilities available to participants whose capacities, histories, and modes of expression differ? The question calls for attention to the institutional consequences of a classification, alongside its adequacy as an account of what it classifies.

Consider a hypothetical interdisciplinary research programme in which substantive contributions are recorded under categories such as *principal investigator*, *technical assistance*, *data preparation*, and *automated generation*. Such categories may be administratively useful. They can also affect compensation, attribution, access to equipment, and the ability to challenge subsequent decisions. A contributor’s work might remain productive despite being entered under a category that provides few opportunities for recognition or advancement. The relevant mechanism involves a translation from observed activity to an institutional record, and from that record to enforceable or practically consequential decisions. Demonstrating the mechanism in a real case would require documentation of the classification rules and evidence that the rules altered treatment relative to a defensible alternative.

The relationship between classification and material reproduction is reciprocal in a practical sense. A system of categories may rely on trained staff, software, contractual obligations, and ongoing data collection. Its outputs can then shape which participants receive resources to maintain their own capacities. The continued operation of the classification itself may also depend on labor and infrastructure that the official categories register only incompletely. Hence, interpretive infrastructure is one possible

component of the conditions under which productive relations persist; it remains analytically distinct from those material conditions and should be examined alongside them.

7.2 Measurement and the Institutional Consequences of Commensuration

Classification commonly precedes or accompanies measurement, but the production of a comparable number introduces additional decisions. Espeland and Stevens define *commensuration* as comparison of different entities according to a common metric and analyze its cognitive and political significance [14]. A common scale can support coordination across organizations, reduce some informational barriers, and make a previously obscure difference available to public scrutiny. It can also compress locally meaningful distinctions into a limited set of measurable dimensions. Political-economic analysis should examine the conditions under which those effects arise, including the institutional uses of the resulting measure.

The choice of unit, aggregation rule, threshold, and reference population deserves particular attention. A performance score can privilege speed over reliability, standardized outputs over locally appropriate work, or immediately visible results over the maintenance that sustains future production. The consequences depend on the uses assigned to the score. A descriptive research indicator, an input to a negotiable decision, and a compulsory eligibility threshold differ in the authority they exercise. The same numerical representation can therefore have markedly different implications for a participant's feasible practices.

Merry's investigation of global indicators in human rights and related fields demonstrates how apparently technical measurement schemes incorporate assumptions about institutions and social change [31]. In a different institutional domain, Power's examination of audit practices traces the expansion of formal verification and the possibility that organizational activities change in response to demands for auditable performance [38]. These works support studying the political character of measurement and audit. They do not entail that every metric is intrinsically coercive or that qualitative descriptions are automatically more faithful. The comparative question is whether a metric's construction, use, and correction procedures are appropriate to its stated purpose and to the consequences it generates.

For heterogeneous GR participants, complete commensuration may be particularly problematic when the evaluated activities differ in constitution as well as in degree. An AI service's computation time, a human researcher's trained judgment, and an ecological process sustaining habitat conditions can all affect a project, yet they belong to different processes and may be evaluated according to incompatible purposes. A single financial or productivity score could be useful for a narrowly stated decision, such as cost accounting. Such a score would provide limited evidence about moral standing, independent agency, or the full reproductive effects of that project. A comparative research design should record these unresolved dimensions explicitly rather than silently treating them as zero-valued contributions.

7.3 Standards and the Distribution of Interpretive Discretion

Standards connect classification and measurement to the continuing organization of practices. A technical standard may improve interoperability, allow reliable comparison, or reduce arbitrary decisions. In research, shared metadata can help institutions exchange results; in ecological monitoring, agreed sampling procedures can improve the comparability of observations; in AI development, structured documentation can make some model and dataset properties inspectable. The political-economic implications arise when participants depend on a standard, when access to standard-setting is unequal, or when standards acquire consequences through procurement, contracting, professional recognition, or regulation.

A standard can distribute discretion across several sites. Its authors select categories and assumptions; institutions adopting it choose enforcement policies; operators decide how borderline cases are treated; and affected participants may have varying opportunities to correct the record or contest an application. These powers should be examined separately. A standard developed through broad consultation can be applied through an inaccessible automated interface, while a tightly controlled technical specification

may still support meaningful independent review if the relevant institutional arrangements require it. Neither the authorship of a rule nor its technical sophistication alone settles the question of legitimate authority.

There is also a difference between *representational portability* and *practical portability*. A person may be able to export a machine-readable record while remaining unable to use it in another institution because credentials, underlying files, legal permissions, or professional recognition do not transfer. An organization may publish a model description while retaining exclusive control over model weights, computation, deployment, and the revision of relevant behavioral policies. In ecological governance, observations gathered through community monitoring can be entered into a shared database without giving those communities any consequential role in the subsequent management decisions. Such examples are possibilities to be investigated, and their evaluation depends on the actual legal, technological, and institutional arrangements.

Interpretive discretion can thus be situated in a chain of processes: selection of a category, collection of admissible evidence, conversion into a recorded value, decision about access or allocation, enforcement, and revision. The chain is an analytical decomposition, since real practices may overlap, recur, and change in different orders. It helps identify the actors responsible for particular decisions without attributing a unified intention to every contributor within a complex infrastructure.

7.4 Interpretive Infrastructures in Human–AI Production

Human–AI production provides a useful setting for studying interpretive power because apparently similar outputs can circulate through markedly different systems of training, maintenance, authorship, ownership, and institutional review. A language model can produce a draft resembling one written by a person, yet the conditions enabling the two outputs may involve different histories of learning, working arrangements, data acquisition, computational operation, and contractual governance. The earlier distinction between task-relative performance and relational constitution becomes politically consequential when a platform’s or institution’s classification of an output determines how its contribution is valued.

Several interpretive decisions may be distributed across the production chain. Training-data documentation shapes what a developer can know about provenance; model evaluations specify which behaviors are measured; deployment rules define permitted uses; a user interface constrains the ways a user can submit instructions or request corrections; and a workplace may decide whether the resulting work counts toward professional evaluation. Each decision has its own responsible institutions and evidential limitations. Model cards and datasheets for datasets offer established documentation approaches that can assist institutional scrutiny, although documentation alone cannot guarantee access to underlying systems or effective remedies [32, 18].

Selbst and colleagues warn that abstracting algorithmic systems from the surrounding social relations can undermine the validity of fairness interventions [42]. A GR comparison can build on this concern by tracing the consequences of abstraction for the reproduction of productive capacities. For example, an organization might measure an AI-assisted employee solely by throughput while recording the model’s cost as a centralized service expenditure. Such accounting could miss time spent checking errors, privacy constraints, maintenance work, skill acquisition, and effects on subsequent independent judgment. Whether those costs are actually displaced is an empirical matter; their possible omission identifies variables that should be audited before drawing conclusions about productivity or value capture.

The terms used to classify AI activities also require discipline. A deployed AI component may be described as an *agent*, *assistant*, or *collaborator* for operational reasons. These labels can aid system design and communication. They do not establish conscious experience, independent legal personality, or a general entitlement to determine governing norms. Conversely, declining to attribute those statuses does not eliminate the economic consequences of the system’s operation, nor the need to identify who sets objectives, controls memory and tools, authorizes deployment, and bears responsibility for harmful outcomes. Political-economic power may be exercised through the institutional design around an AI service even when the service itself has no recognized standing as an independent rights-holder.

A second asymmetry involves access to evidence about decisions. A user may observe the service output while lacking information about data provenance, model updates, refusal policies, tool permissions, and the reasons for changes to the service. The provider may possess greater access to system-level information while lacking the user's situated knowledge about downstream effects. The resulting asymmetry is multidirectional rather than reducible to one general hierarchy of intelligence. A study of interpretive infrastructure should ask which participant can disclose evidence, challenge an interpretation, revise a rule, or switch to a meaningful alternative without disproportionate loss of productive capacity.

7.5 Cross-System Representation and the Limits of Normative Attribution

The problem extends to relations with other forms of life and to institutions responsible for ecological stewardship. Measurements of species abundance, environmental quality, or habitat change can support conservation, but their interpretation is mediated by sampling procedures, scientific concepts, management priorities, and legal categories. Ecological processes may be materially affected by these decisions even though the organisms involved do not participate through the same linguistic or institutional channels as human decision-makers. The relevant issue is therefore how their conditions and interests are represented, by whom, and with what opportunities for external criticism and scientific correction.

The IPBES assessment of diverse values and valuation of nature provides an established basis for distinguishing multiple forms of ecological valuation [27]. A preliminary GR analysis can use this plural approach to examine differences among ecological observation, community interpretation, administrative classification, and management decisions. It must also preserve the gap between a human institution's representation of ecological interests and direct evidence about an organism's experience or normative commitments. Claims about ecological harm can often be supported by ecological measurement even where stronger claims about moral agency remain unestablished.

Cross-system interpretation may also generate conflicts that cannot be resolved through a more detailed common indicator. A stakeholder might value a marine habitat for its ecological continuity, another for subsistence, and another for scientific knowledge. Quantitative information may clarify trade-offs and causal effects while leaving genuine disagreements about obligations and acceptable losses. A negotiated standard can be operationally useful without being the complete translation of every participant's values. In this setting, norm-making authority includes the authority to determine how competing interpretations enter a decision process, whose reasons are recorded, and which disagreements remain visible after a decision is implemented.

This issue is especially clear in hypothetical encounters with technologically superior nonhuman intelligences. An external civilization might possess advanced instruments and extensive knowledge while remaining unfamiliar with the historically formed meanings of human political freedom, kinship, or institutional legitimacy. Its capacity to describe human practices with apparent accuracy would not establish a right to govern their terms. The example is a conceptual reversal of familiar power positions; it supplies neither empirical evidence about extraterrestrial beings nor a comprehensive theory of first-contact ethics. The latter questions, including the evolutionary formation of provisional shared norms, belong more directly to the separate study of normative coevolution. Here the point concerns the distribution of power over the representations through which one system's conditions become actionable to another.

7.6 Effective Rule-Setting and Legitimate Normative Authority

Interpretive infrastructure connects with authority when its outputs structure obligations, permission, or practical consequences. The present inquiry distinguishes three objects: the capacity to produce an interpretation; the effective power to make that interpretation consequential; and the normative justification for an institution's exercise of that power. An expert body may create a classification without deciding its use. A platform may enforce a policy developed elsewhere. A public authority may possess legal competence to mandate reporting while facing unresolved questions about procedural fairness or the substantive effects of its chosen standard. The relevant powers can be located in different organizations and justified according to different institutional norms.

Table 6: Evidence for interpretive authority and its political-economic effects in two heterogeneous settings.

Institutional process	Human–AI research and production	Ecological monitoring and management
Category formation	Task roles, authorship categories, AI contribution labels	Habitat classes, species indicators, ecological risk categories
Measurement design	Output metrics, error rates, maintenance and human review	Sampling protocols, indicators, thresholds and uncertainty
Decision consequence	Access, compensation, procurement, approval or restriction	Resource allocation, permits, conservation and repair
Revision control	Platform policies, employer discretion, evaluation committees	Standard setters, regulators, scientific and local bodies
Affected-party access	Documentation, explanations, data portability, appeals	Public records, community evidence, independent review
Reproductive effects	Skill development, dependence, continuity of usable tools	Habitat condition, monitoring capability, displaced burdens

The notion of *norm-making authority* is therefore used carefully. In a descriptive political-economic analysis, it may denote effective control over the procedures through which rules are specified, enforced, or revised. In a normative or legal evaluation, authority additionally concerns the grounds on which affected participants should recognize that control as justified. Compliance with a measurement standard is evidence that conduct falls within its requirements; endorsement requires a different kind of evidence, and legitimacy requires an appropriate substantive or procedural argument. This distinction is important when unequal dependencies make refusal costly.

Meaningful contestability can be analyzed through several institutional capacities. An affected participant may be able to inspect the representation applied to them, correct relevant factual errors, introduce evidence expressed in a different vocabulary, request a reasoned review, appeal a consequence, or participate in revising the standard. These opportunities differ in practical availability. A nominal appeal mechanism may be inaccessible without technical expertise or legal support; a documented right to withdraw may be insufficient when essential records and tools cannot be transferred to an alternative provider. Consequently, investigating contestability also requires examining resources, knowledge, time, and the ability to sustain an activity while the dispute is unresolved.

The existence of interpretive power, however, does not entail that every act of classification is an instance of domination. Standards may protect participants against arbitrary treatment, strengthen safety, preserve reliable public data, and enable remedies. A defensible comparison should examine both coordination benefits and asymmetries in control. Nor can the absence of complete consensus be treated as evidence that every rule is invalid. Practical institutions often need provisional standards under uncertainty, with different forms of representation, review, and revision appropriate to different consequences. G2's object is the political-economic distribution of these capacities and burdens; G3's more specific question concerns the evolution of the norms that participants come to adopt through interaction.

7.7 Comparative Evidence for Interpretive Power and Institutional Revision

An empirical investigation should trace how an interpretive infrastructure is made, applied, and revised, together with the consequences for distinct participants. Table 6 gives a provisional register for two illustrative settings. The comparison concerns potential objects of observation rather than already established findings. It is intended to identify conditions under which a conventional account of classification or institutional governance already suffices, and conditions where a cross-system account of generative capacities may add explanatory precision.

Two kinds of inquiry are especially useful. A *process-tracing study* reconstructs the decisions that connect a classification to an enforceable consequence: who proposed a category, whose evidence in-

formed it, how it was implemented, how exceptions were treated, and what occurred when its validity was challenged. A *comparative institutional study* examines similar practices across settings with different access, revision, or appeal arrangements. The researcher can then ask whether differences in interpretive control help explain changes in recognition, value allocation, or the continuation of productive activity, while considering alternatives such as resource constraints, task complexity, legal duties, and variation in local circumstances.

A targeted intervention can provide stronger evidence where its ethical and legal conditions permit. For example, two otherwise comparable institutional workflows might receive the same substantive data but different opportunities to provide contextual corrections before a consequential classification is finalized. Outcomes could include factual error rates, frequency of revisions, decision delays, unequal burdens of documentation, and subsequent access to productive resources. Such a study would need to separate a genuine improvement in understanding from strategic adjustment to evaluation criteria. An increase in appeals might indicate greater access to contestation as readily as dissatisfaction with the system; the observation therefore requires interpretation in relation to the available procedural alternatives.

Disconfirming evidence is also important. If classification rules are transparent, contestable, and equally accessible, and if changes to interpretive discretion have little effect on the capacities or allocations being studied, a hypothesized channel of structural dependence may receive limited support. If a conventional institutional account already explains the observed variation, a distinct GR interpretation may add little. Stronger evidence for the proposed extension would involve identifiable cases in which heterogeneous formative histories or maintenance conditions explain consequential differences that ordinary output-based classifications leave unexplained. The relevant comparisons must be made within defined populations, institutions, and observational limits.

Interpretive infrastructures thus occupy a recognizable position within the political economy of heterogeneous GR subjects. They mediate the recognition of activity, the institutional translation of value, and the circumstances under which rule-setting becomes consequential. Their effects depend on standards, material dependencies, permissions, and channels for revision. The conceptual contribution proposed here is a differentiated way to investigate these relations across human, artificial, and ecological participants while recognizing the extensive antecedent work on classification, commensuration, auditing, and sociotechnical governance. The following section examines the concrete organization of human–AI production more closely, including the distributed controls over computation, training, labor, deployment, and the uses of generated work.

8 Political-Economic Relations in Human–AI Systems

Human–AI production offers a comparatively accessible setting in which to investigate how similar productive outputs can depend on heterogeneous generative-relational (GR) conditions. This section examines the organization of artificial-intelligence services as a layered political-economic arrangement involving people, models, organizations, infrastructures, and institutions. Its objective is to identify where productive capacities arise, where the conditions of their exercise are controlled, and how benefits, maintenance burdens, and opportunities for revision are distributed. The discussion proceeds through a comparative institutional analysis of development inputs, data and labor, computation and deployment, user practices, and arrangements of responsibility. It concludes with an evidential register for examining particular deployments. The analysis treats contemporary AI systems as technically operative participants within organized relations; attribution of consciousness, moral personhood, or independent normative authorization remains a separate inquiry.

8.1 Layered Production and the Allocation of Effective Control

A deployed AI service may appear to an observer as one interlocutor carrying out a coherent task. Its operation nevertheless involves distinct activities and authorities. Hardware designers and manufacturers supply computational equipment; data-centre operators maintain physical facilities, electricity, cooling,

and connectivity; cloud vendors allocate remote computational capacity; model developers select architectures, training regimes, and evaluation procedures; application providers integrate models with interfaces, tools, datasets, and commercial rules; organizations establish terms of use and operational safeguards; users contribute purposes, instructions, information, labor, and judgment. These roles may be combined within one firm, delegated contractually, or distributed among organizations with conflicting interests. The OECD’s account of AI infrastructure presents this multilayered supply chain as an important setting for competition analysis [33]. Its later market review identifies concentration in critical inputs, switching costs, and vertical integration as potential sources of competitive constraints while also documenting rapid changes and entry in some model segments [34].

The relevant political-economic unit therefore depends on the question under examination. For a task-performance comparison, a deployed model and a human worker may be treated as alternative means of generating a particular output. For analysis of institutional control, the more appropriate units may be a model provider, contracting employer, cloud operator, and user organization. For analysis of training and reproduction, the relevant network also includes data contributors, annotators, maintainers, educators, energy suppliers, and communities affected by infrastructure. The conceptual term *heterogeneous GR subject* is used provisionally to permit comparisons among these differentiated participants and systems. Their formal rights, material needs, agency, and moral standing remain distinct.

A useful inquiry traces at least three arrangements for each service: the *productive arrangement* through which an output is generated; the *control arrangement* specifying who can permit, modify, audit, interrupt, or reproduce its production; and the *reproductive arrangement* through which software, knowledge, equipment, labor, and other conditions are maintained. An organization may hold contractual rights to a generated document while relying on an externally hosted model to reproduce or revise its underlying analysis. Conversely, a small organization may operate an openly available model on controlled hardware yet remain dependent on specialized chips, software ecosystems, datasets, or expertise. The relevant dependencies must be identified case by case. Technical ownership, contractual permission, legal rights, and practical command over a system’s operation are related but distinguishable variables.

8.2 Training Data, Distributed Labor, and the Formation of Productive Capacity

Artificial model capabilities emerge through organized processes of data collection, preparation, training, evaluation, and deployment. Datasets can include licensed archives, publicly accessible materials, expressly contributed content, synthetic records, and organizational data under specific access arrangements. The permissibility and governance of particular uses depend on applicable law, contractual agreements, institutional practices, and the characteristics of the data. A claim that material is technically available therefore cannot alone establish a general permission to appropriate, repurpose, or commercially exploit it. Dataset documentation can help make collection decisions, exclusions, representational limits, and recommended uses inspectable, although documentation does not resolve every problem of authorization or remedy [18, 4].

The labor needed to build and operate these systems also extends beyond visible research and engineering. Annotation, filtering, red-teaming, evaluation, customer support, safety review, content moderation, operations, and the work of users correcting outputs may all affect a service’s quality and continued availability. Gray and Suri’s work documents forms of human work that remain difficult to recognize within apparently automated digital production [20]. The present discussion takes that established insight as a basis for examining *the distribution of recognition, control, remuneration, and repair*. It does not assume that every interaction constitutes employment or that every data contribution deserves the same type or magnitude of payment. Those questions require further institutional and normative evaluation.

A distinction is needed between *contributing to a capacity* and *controlling the resulting capacity*. A researcher whose publications enter a corpus, a contractor who labels examples, a developer who tunes a system, and an organization that purchases compute may jointly enable a later model capability while holding sharply different powers to license the resulting system, inspect the training pipeline, challenge a use, or receive economic returns. Contribution histories are also technically difficult to reconstruct:

aggregate training involves interactions, selection, filtering, model optimization, and subsequent adaptation. Simple attribution of a particular answer to a particular document or worker can therefore be unreliable. A serious political-economic analysis must distinguish demonstrable input provenance from causal attribution and from the normative judgment that some contribution warrants compensation or recognition.

The GR perspective proposes an additional comparative question. To what extent do the institutions converting distributed contributions into deployable model capacities return resources, knowledge, or practical opportunities to the people and communities whose work and data were involved? Such a question is compatible with established accounts of value creation and capture, yet it directs attention to the maintenance of future productive conditions, as discussed in the manuscript’s earlier treatment of generative circulation. Its evaluation may require distinct measures for pay, consent, access to models, labor protection, knowledge sharing, and the ability to participate in governance. These measures need not form a universal scalar index.

8.3 Compute, Energy, and the Material Organization of Access

Computational resources shape the feasible design, training, adaptation, and operation of contemporary AI services. Large-scale training can require specialized accelerators and extensive engineering, while deployment and inference depend on workload, model architecture, service requirements, latency, and the availability of supporting facilities. Stanford’s 2025 AI Index reports that industrial organizations accounted for nearly 90 percent of identified notable AI models developed in 2024 and describes rising compute requirements among notable models [44]. These indicators describe a specified historical sample and should not be generalized to every AI technique, community model, or local deployment. Access to lower-cost inference, efficient architectures, shared research resources, and locally deployed models can also modify the distribution of practical opportunities.

Material infrastructure places limits on abstract accounts of artificial production. The International Energy Agency estimated that data centres as a whole consumed approximately 415 terawatt-hours of electricity in 2024; this figure covers general data-centre activity and therefore should not be represented as a measurement of AI electricity use alone [24]. Electricity procurement, grid capacity, cooling, water use, hardware turnover, maintenance labor, and waste arrangements connect AI services to local environments and institutional responsibilities. The relevant impacts differ by technology, geography, electricity mix, and deployment. The fact that an AI application appears intangible to its user does not make its operation materially independent.

Compute-related political power can arise through several mechanisms. A provider may determine who receives advanced accelerators, the price and continuity of service, permissible workloads, data residency, service-level commitments, and the technical possibility of transferring an application elsewhere. Such discretion may be constrained by contracts, law, competition, public governance, and technological alternatives. A developer relying on third-party compute may have considerable expertise yet limited authority to maintain a model during a contractual dispute or infrastructure disruption. A downstream organization may likewise acquire an advanced service while losing part of its independent capacity for reproduction if it cannot export data, verify performance, or switch providers on workable terms. These are contingent institutional relations, rather than necessary properties of artificial systems.

It is therefore useful to distinguish *access to advanced capability* from *the capacity to reproduce or replace that access*. Lower inference prices can widen participation, including for smaller organizations; dependence can nevertheless persist where application data, proprietary interfaces, contractual restrictions, or specialized integrations make substitution expensive. OECD competition analysis addresses both technological dynamism and structural barriers at different layers of the AI value chain [34]. A GR extension would investigate how these layers jointly condition the continued feasibility of particular activities, while allowing market, institutional, and technological explanations to compete.

8.4 Deployment Interfaces and the Distribution of User Agency

A model’s observable behavior is mediated by the application in which it is deployed. An interface may select what evidence the model can retrieve, which external tools it can operate, how recommendations are presented, whether uncertainty is disclosed, what records are retained, and how a user can correct or appeal an output. The same underlying model can therefore support different patterns of decision-making and control across institutions. Model documentation, evaluation procedures, and dataset disclosures supply parts of the evidence needed to understand those settings [32, 18]. The interpretive and consequential aspects of such mediation are relevant to the classification mechanisms examined in the preceding section.

Human agency within these arrangements also varies by task. A researcher using an AI system to generate possible hypotheses may retain the ability to inspect sources, modify methods, and reproduce an analysis independently. An employee required to accept algorithmically mediated work assignments, evaluations, or forecasts may have narrower opportunities to challenge or circumvent the system. A public institution may use AI to support administrative work while remaining responsible for decisions made under its authority. Similar conversational fluency across these contexts does little to determine how institutional power is allocated. The pertinent questions concern permission to inspect, refuse, correct, modify, transfer, and discontinue the system, and the availability of meaningful alternatives.

AI assistance may expand users’ feasible practice sets through translation, coding, tutoring, information retrieval, or scientific support. It may also create new forms of dependence when users lose access to a formerly independent workflow, when indispensable records are confined to proprietary services, or when a system’s suggestions become difficult to contest. Both tendencies can occur within one arrangement. Effects should be evaluated over relevant periods and against explicit comparison conditions. A short-run gain in output quality does not by itself resolve whether an organization acquires durable research capabilities or becomes dependent on a vendor’s continuing service. Conversely, outsourcing particular capabilities can be economically sensible and collectively beneficial where accountability, portability, and substitution remain effective.

The distribution of responsibility needs equal scrutiny. Elish’s analysis of the *moral crumple zone* illustrates how humans may be assigned responsibility for outcomes of automated systems even when their practical influence over design and operation is limited [12]. An institutional diagnosis can compare nominal oversight duties with actual access to evidence, intervention rights, time for review, and authority over deployment conditions. In this paper, the analytical distinction is among *performing a task*, *directing the conditions of its performance*, and *bearing the consequences*. Their divergence can be politically consequential without settling the moral status of the deployed model.

8.5 Value Distribution, Occupational Change, and Institutional Responsibility

The distribution of economic returns from AI-assisted production involves contractual, organizational, labor-market, and public arrangements. Providers may receive subscription or infrastructure revenue; deploying organizations may gain profits or reduced costs; workers and users may gain time, income, knowledge, or expanded services; communities may experience employment adjustments, changed public service quality, and material infrastructure costs. These gains and burdens may coexist, and a single aggregate indicator may obscure their distribution. The central comparative question is which participants gain additional possibilities for continued activity and which bear new constraints or maintenance obligations.

Labor-market exposure should be distinguished from actual displacement. The International Labour Organization’s 2025 task-based assessment estimates that approximately one quarter of global workers were employed in occupations exhibiting some exposure to generative AI, with particularly high exposure in clerical occupations and variation across economies and occupational groups. The assessment examines potential occupational exposure and emphasizes the likelihood of task transformation in many occupations; it does not establish an equivalent realized percentage of jobs lost [25]. Any inference about wages, bargaining power, replacement, labor intensity, or skill development requires further empirical

work in specified employment settings. Exposure estimates can frame research questions but cannot substitute for longitudinal observation of particular labor markets and workplaces.

Within organizations, productive gains can be allocated through different mechanisms. Employees may retain discretion to redesign workflows and invest saved time in training; management may intensify performance targets; customers may receive lower prices; service providers may capture a higher share of revenue; public agencies may reorganize budgets and responsibilities. The existence of a productivity gain does not select among these outcomes. Moreover, measured productivity may exclude work displaced to customers, outsourced evaluators, or public infrastructures. The social reproduction of skills, care, and institutional competence discussed earlier in the manuscript remains relevant when apparently efficient systems depend on less visible labor.

Distributive analysis must also distinguish economic value from moral standing. Describing an AI application as a productive participant permits assessment of operational roles and dependencies. That terminology does not establish that a present system possesses interests comparable to those of a human worker or should receive a share of revenue in its own right. Questions concerning future artificial subjects with different capabilities and forms of normative agency remain open. Political-economic accountability in current deployments can meanwhile be examined through identifiable firms, workers, users, regulators, and affected communities with established institutional roles.

8.6 Institutional Alternatives and the Conditions of Durable Capability

Human–AI political-economic relations admit more than one organizational form. Proprietary hosted services, organizationally controlled deployments, publicly supported compute facilities, cooperatively governed data arrangements, open-model ecosystems, and hybrid partnerships distribute risks and decisions differently. Each arrangement involves trade-offs in cost, expertise, safety, reliability, energy use, privacy, access, and accountability. A publicly controlled installation may offer more discretion to a research community while imposing significant maintenance burdens; a competitively supplied hosted service may provide sophisticated capability at lower cost while creating exposure to changes in pricing or terms. The appropriate evaluation depends on the institution’s purposes, affected participants, available alternatives, and actual governance rules.

The present framework proposes an analysis of *durable capability* through three dimensions: continuing access to a productive service; practicable means of substituting, repairing, or reorganizing that access; and effective participation in consequential decisions about its use. These dimensions describe different possibilities and need not move together. A service may be reliably available without being contestable, or contestable in principle without economically feasible alternatives. Their relative importance is context-dependent. Public investment, contractual portability, open standards, user organization, worker participation, and independent assessment may change these conditions, but each proposal requires legal, financial, and empirical evaluation in the relevant setting.

The association between choice and autonomy also depends on genuine feasibility. Multiple nominal providers offer limited practical choice when incompatible interfaces or migration costs make switching prohibitive. Conversely, exclusive control over a narrow technical component may have limited downstream influence where substitutable systems and effective institutional remedies are available. The inquiry should measure access, exit, voice, review, and the ability to alter productive arrangements separately. These considerations connect familiar competition and organizational analysis to the GR question of how changes in one participant’s institutional decisions modify the generative conditions available to others.

8.7 Comparative Evidence for Human–AI Political-Economic Arrangements

The layered analysis can be operationalized by tracing one identifiable deployment from its stated task through training and procurement conditions, operation, monitoring, and possible withdrawal. Table 7 presents a comparative evidence register. Each row concerns a specific power relation, and the proposed evidence should be gathered under appropriate access, privacy, and research-ethics constraints. A strong

Table 7: Evidence register for the political-economic organization of human–AI services

Relation examined	Potential evidence	Interpretive limitation
Training and formative contribution	Data provenance, contracts, labor records, documentation and evaluation procedures	Input presence alone does not quantify causal contribution or entitle a specific return.
Compute and service dependence	Procurement terms, energy and compute accounts, service outages, capacity allocation	Market concentration alone does not demonstrate decisive control in a particular case.
Interface and operational discretion	Tool permissions, audit logs, error correction, suspension and appeal procedures	Nominal user oversight may exceed practically available intervention.
User and worker capability	Workflow studies, skill retention, portability tests, longitudinal outcome measures	Short-run task gains may differ from changes in durable independent capacity.
Value and burden allocation	Revenue, wages, costs, maintenance labor, environmental assessments	Economic indicators capture only selected dimensions of value and reproduction.
Rule-making and revision	Policy-change histories, stakeholder participation, complaint and remedy outcomes	Observed compliance alone cannot establish consent or legitimate authority.

study would also identify relevant counterfactual arrangements and alternative explanations: differences in market competitiveness, organizational competence, skill composition, legal obligations, or product reliability may account for observed outcomes without invoking a distinct GR mechanism.

Such evidence enables a distinction between describing a value chain and explaining a relation of dependence. A provider's role in operating an AI service is an observation about production organization. A claim that the provider can restrict a user's feasible research options requires further evidence about alternatives, contracts, the affected tasks, and actual intervention rights. A claim of illegitimate domination requires an additional normative argument specifying the relevant authority, participants, rights, and standards of justification. Comparative work should preserve these stages rather than move directly from visible technical centralization to a moral verdict.

The specific GR contribution sought here is therefore modest but potentially useful: a comparative account that connects heterogeneous histories of capacity formation to the institutional ability to reproduce, limit, or reorganize others' productive practices. Its evidential value would increase if these relational measures explain variation that output-based performance comparisons, conventional market measures, or single-firm governance accounts leave unresolved. Conversely, where established economic and institutional models provide adequate explanations, the GR vocabulary should remain an organizing perspective rather than a claim of independent causal discovery. These questions prepare the next section's examination of how the authority to choose initial rules and allocate risks becomes consequential when the interacting systems lack settled common norms.

9 Control of Normative Initialization in Heterogeneous Encounters

The political economy of heterogeneous generative-relational (GR) subjects requires attention to the arrangements through which participants first acquire access to a shared interaction. Initial communication formats, permission structures, allocations of risk, and procedures for revising provisional rules may have durable effects on the activities available to differently constituted participants. This section examines the distribution of control over those arrangements. It first identifies initial protocols as consequential institutional choices, then considers control over communication and evidentiary channels, the assignment of risk and maintenance burdens, and the authority to represent affected interests. Human–AI enrollment provides an institutionally observable comparison, while planetary protection and extraterrestrial communication offer carefully bounded thought experiments. The final subsection specifies evidence for identifying initialization power. The argument is political-economic and comparative: it investigates the production and allocation of practical conditions for an encounter, while leaving the detailed evolution

of shared norms to a separate inquiry.

9.1 Initial Protocols as Allocations of Practical Possibility

An *initial protocol* is understood here as a locally effective arrangement determining how potential participants can enter an interaction, what kinds of actions or signals are permitted, how information is registered, and who may interrupt or revise the arrangement. An initial protocol can be explicit, as in a contract governing access to a digital service, or implicit, as in the choice to approach an unfamiliar animal species through an established observational method. The adjective *initial* is indexed to a particular relation being investigated. It designates the starting configuration of that relation within a model or history of interaction, without asserting that any participant or world possesses an ontologically privileged beginning.

Protocols create and constrain feasible practices. A service may initially permit observation without intervention; a research collaboration may permit data access while reserving publication decisions to one organization; a prospective interlocutor may be offered only a predetermined set of response categories. These arrangements can support predictability and reduce some risks. They can also preselect the kinds of activity that later become visible as cooperation, disagreement, noncompliance, or absence of interest. An apparent absence of objection is especially ambiguous where the chosen interface offers no practical means to object.

This suggests distinguishing *the authority to propose* an initial rule, *the capacity to implement* it, and *the legitimacy of making it binding*. One actor might write a provisional protocol, another supply the material infrastructure through which it operates, and a third possess a legal or organizational mandate to authorize its use. A technically enforceable interface can therefore distribute powers across several institutions. The resulting division of control deserves empirical analysis before a verdict is reached about responsibility or normative legitimacy. Power-dependence theory, exit and voice, and institutional studies already furnish important resources for examining such distinctions [13, 22, 35].

A further distinction concerns ordinary defaults and rules imposed under conditions of restricted alternatives. Many encounters require a provisional starting arrangement. The institutional question is whether participants can inspect the rule, refuse entry, use an alternative interface, change the arrangement, or later obtain remedy for harmful consequences. A default with transparent revision opportunities differs materially from a default backed by exclusive control over essential infrastructure. The difference arises through the affected participant's practical options rather than through the formal wording of the rule alone.

9.2 Communication Gateways and the Control of Encounter Timing

The organization controlling an encounter's communication gateway can influence what qualifies as a response, how rapidly a response must occur, and which evidence can become available to other participants. A proprietary protocol might require a particular identity credential, restrict messages to a limited vocabulary, filter some inputs automatically, or allow only authorized operators to receive raw observations. Comparable constraints can arise through translation devices, sensing equipment, documentation practices, or institutional permission to transmit a signal. The gateway can thus shape the range of possible future interaction without a public declaration of rule-making authority.

Timing and sequencing also have political-economic consequences. A participant able to initiate contact repeatedly while others can respond only during a narrow window may control opportunities for deliberation or verification. A platform that applies a rule change immediately while allowing users to request review only after a suspension distributes different degrees of initiative and delay. Where one organization can prevent the preservation of previous interaction records, it may also control the evidence available for contesting the initial conditions. Such mechanisms should be investigated through observed permissions and documented procedures. They should not be inferred solely from unequal technical sophistication.

Interpretive infrastructure is especially important at this stage. Classification schemes determine whether an unfamiliar response is registered as meaningful communication, an error, a safety anomaly, or prohibited behavior. As research on classification and sociotechnical abstraction has shown, representational schemes can acquire practical consequences through their institutional uses [6, 42]. In an encounter between heterogeneous systems, a classification may remain uncertain because a participant's signals, abilities, and interpretive criteria are only partially understood. That uncertainty does not eliminate the need for operational decisions. It increases the importance of documenting the adopted interpretation, retaining potentially conflicting evidence, and allowing the interpretation to be challenged.

These are proposed safeguards, not universally valid directives. Their desirability may depend on the interests affected, the cost of maintaining additional information, security and privacy constraints, and the possibility that a particular signal itself alters the encounter. A procedure designed to minimize an unfamiliar risk may itself impose a substantial burden on a party whose communications are delayed or whose forms of expression remain unrecognized. Evaluating an initial protocol therefore requires identifying the participants who bear such costs and the institutions able to change their distribution.

9.3 Irreversibility, Risk Allocation, and the Burdens of Maintenance

Some initial interventions change the conditions under which later interaction is possible. Exposing a participant to a new environmental agent, publishing sensitive information, replacing an existing infrastructure, or placing a community under a compulsory data standard may produce consequences that are difficult to reverse. The degree of reversibility is context-specific: an intervention can be technically reversible yet economically costly, contractually irreversible yet socially renegotiable, or reversible for one participant while imposing persistent losses on another. Political-economic comparison should therefore record reversibility from the positions of differently situated actors.

The actor selecting an initial protocol may differ from the actors who absorb its consequences. A laboratory chooses its observation method while a monitored community bears a privacy burden; an AI provider specifies operating defaults while a user organization undertakes retraining and workflow adaptation; a conservation authority regulates habitat access while nearby communities or species are affected through different pathways. These illustrations do not establish that the respective choices are wrongful. They show why a description of initial decision-making authority should be accompanied by an account of the costs of compliance, the distribution of residual risks, and the resources available for repair.

Analytically, the *risk bearer*, *decision holder*, *beneficiary*, and *repair provider* may be different participants. In some arrangements, the actor empowered to interrupt an encounter also decides whether evidence of harm is sufficient to trigger review. In others, the institution able to prevent or mitigate a disturbance is excluded from the initial decision. The consequential asymmetry lies in this allocation of options and obligations. It can be studied through contracts, risk registers, organizational budgets, records of adverse events, and counterfactual feasible alternatives. The environmental and infrastructural maintenance costs identified earlier in the paper are especially relevant because the apparent success of a short initial interaction can depend on resources supplied elsewhere.

Choosing the least disruptive available action may be an appropriate provisional objective in some settings. Such a recommendation would require specifying what counts as disruption, whose losses are included, and which possibilities for learning or remedy are preserved. Under radical normative heterogeneity these quantities may be only partially measurable, and a delay or refusal to act may itself change the prospects of the encounter. The present political-economic inquiry consequently treats precaution as a contestable institutional policy with distributive consequences, rather than an automatic solution to the ethics of initial contact.

9.4 Representation and Authority over the Terms of Negotiation

The party speaking first, supplying the technical interface, or issuing an invitation may be mistaken for the representative of a wider population. In collective settings, representation requires attention to both the

mandate of the speaker and the interests excluded from the process. An organization may be authorized to negotiate on behalf of its members while lacking authority over an adjacent ecological community; a government may speak through recognized diplomatic channels while the interests of some affected populations remain weakly represented; a technology provider may supply an interface without authority to settle every normative dispute concerning the people who use it.

Young's account of political inclusion is relevant because formally open decision procedures can still marginalize groups with less economic power or different modes of political expression [51]. The contribution of that scholarship lies in diagnosing asymmetries within human political institutions. Extending its questions to heterogeneous GR systems is a separate proposal. A human council, a network of organizations, a nonhuman animal population, and an artificial service do not necessarily possess the same kinds of representatives or mechanisms for authorizing them. An analyst should specify whether representation is legal, delegated, epistemic, protective, or merely asserted by a third party.

Initial negotiation can also be shaped through agenda control. If one participant determines the questions under discussion, the baseline from which concessions are measured, and the grounds on which a response counts as reasonable, formal opportunities to participate may coexist with substantially unequal influence. A consultation can invite commentary while excluding participants from revising its categories, selecting interpreters, or proposing alternative institutional arrangements. The distinction between *being consulted* and *having an effective opportunity to shape the decision* can be evaluated through procedural records and observed changes following objections. Its normative implications depend on the particular governance arrangement and affected rights.

In interactions involving participants whose communicative capacities are uncertain, direct representation may be unavailable or contested. There may be reasons to appoint advocates, scientific interpreters, trustees, or independent evaluators as provisional intermediaries. Each such appointment raises a further question of who selects the intermediary, how its claims are verified, and how competing interpretations are considered. The institutional solution cannot simply be read off from an asserted hierarchy of intelligence. Technical expertise may improve the prediction of consequences while providing limited authority to determine another community's values or institutional future.

9.5 Human–AI Enrollment and the Political Economy of Defaults

Human–AI relations provide observable examples of initialization power without assuming that a contemporary AI service is an independently sovereign or morally authorized agent. A provider can determine the technical conditions under which a user begins an interaction: default privacy settings, tool permissions, available models, logging retention, content restrictions, disclosure practices, and routes for requesting a change. An employer can select an AI system for its workers, decide whether its use is mandatory, and determine how results are evaluated. A user may in turn choose whether and how to rely on the system, subject to the options materially available. These are different institutional positions within the same service relation.

The NIST AI Risk Management Framework provides a relevant practical antecedent by organizing voluntary organizational risk management around governance, context mapping, measurement, and management across the AI lifecycle [48]. Its relevance here is procedural: it helps identify which actors document risk, allocate responsibility, and manage the consequences of deployment. It does not attribute independent normative self-legislation to present AI systems, nor does adherence to a risk framework by itself establish the legitimacy of every default setting. The G2 question concerns how operational authority at enrollment shapes the set of practices that human users, workers, and institutions can later pursue.

Consider a hypothetical research organization enrolling staff in a centralized AI analysis platform. The initial contract may permit efficient document preparation while requiring data storage on provider-controlled servers, prohibiting independent audit of some model decisions, and conditioning continued access on new service policies. Other implementations could permit local processing, independent review, export of records, and human control over the adoption of changed rules. The contrast illustrates

the role of default configurations and switching costs; it does not prove a general superiority of a particular architecture. Relevant evidence would include terms of service, available alternatives, technical portability tests, policy revision histories, actual labor practices, and the incidence of disputed outcomes.

A further complication is that apparent initial acceptance may be an organization-level decision rather than an individual's agreement. Workers could be required to use an AI tool even where they lack authority to alter its operation or consent meaningfully to monitoring conditions. The system's outputs may appear responsive to human input while the substantive rights to inspect, modify, retrain, interrupt, or replace it remain distributed elsewhere. Thus the political economy of human–AI initialization concerns several linked interfaces: the human–AI interaction, the provider–user contract, the employer–worker relation, and the institutional governance of the underlying compute and data infrastructure. Treating the conversational exchange alone as the unit of analysis would conceal much of this allocation of power.

9.6 Planetary Protection and SETI as Bounded Institutional Analogies

A hypothetical encounter with extraterrestrial intelligence provides a reversal of the power relation familiar from much human governance of other terrestrial beings. A technically more capable civilization might offer a protocol framed as protection, coordination, or the provision of valuable infrastructure. Human participants could enjoy substantial productive benefits while retaining limited control over the conditions on which those benefits depend. Alternatively, a technologically advantaged interlocutor might support autonomous capacity, plural institutional development, or mutually agreed safeguards. The thought experiment tests whether claims about expertise and welfare are being used consistently when human beings occupy the less powerful position. It offers no evidence that extraterrestrial civilizations exist or would act in either way.

Human scientific institutions already have limited procedures concerning extraterrestrial-relevant encounters. The International Academy of Astronautics' 2026 declaration concerning astronomy-based SETI calls for international consultations before any reply to a confirmed detection and specifically envisages participation through the United Nations and other broadly representative international bodies [23]. This is an advisory framework for scientific detection and communication, not an enforceable constitution for direct diplomatic relations with an extraterrestrial civilization. It also leaves further arrangements to future institutional development. The example is relevant because it makes the authority to send an initial response a collective governance question rather than treating the technical ability to transmit as sufficient authorization.

The COSPAR planetary-protection policy provides a different analogy [7]. Its 2026 revision concerns the scientific and technical governance of contamination risks associated with space exploration, including a revised unified approach to icy worlds. Planetary protection addresses specified biological and mission-related hazards; it does not settle the ethical or political status of intelligent extraterrestrial interlocutors. Read together, these institutional cases illustrate distinct dimensions of initialization: management of a material risk and authorization of a consequential communication. Neither establishes a universal norm for all possible encounters or resolves representation of Earth's nonhuman life.

The comparison returns attention to terrestrial multispecies relations. Humans frequently choose initial conditions for conservation, monitoring, habitation, or intervention affecting other species. The material advantages of human tools can translate into the capacity to set habitat boundaries, designate acceptable contact, and determine what counts as an ecological benefit. Yet differences in biological organization, interdependence, and evidence of interests mean that these cases cannot simply be identified with negotiations between two human states or two technologically advanced civilizations. Their common analytical question concerns how control over the first effective protocol can distribute practical possibilities and burdens across heterogeneously constituted participants.

9.7 A Comparative Register for Investigating Initialization Power

The central empirical task is to reconstruct a particular encounter's operating conditions and identify which institutions could have chosen differently. Table 8 organizes that task around observable allo-

Table 8: Comparative evidence for the allocation of control over initial encounter conditions

Analytical dimension	Evidence to examine	Interpretive boundary
Entry and interface rules	Enrollment conditions, communication protocols, credentialing and permission records	A formal right to enter may coexist with practically inaccessible participation.
Initiative and timing	Contact opportunities, response deadlines, interruption and suspension logs	Delay may be protective, exclusionary, or both depending on its circumstances.
Interpretive discretion	Classification rules, translation records, retained raw evidence, correction procedures	Agreement within one representation need not imply equivalent internal meanings.
Risk and maintenance	Incident assessments, repair budgets, responsibility assignments, ecological monitoring	Measured costs can omit deferred and cross-system reproductive burdens.
Representation and mandate	Delegations, consultation records, affected-interest mapping, evidence of influence	Technical expertise alone does not establish authority to represent all affected interests.
Revision and exit	Appeals, rule changes, alternative channels, switching and portability tests	Written possibilities for refusal or exit may be materially unavailable.

cations of decision authority, material dependence, risk, and corrective opportunity. It is a register for research design rather than a universal ranking of encounter protocols.

A comparative inquiry could first reconstruct the operative protocol using contracts, technical specifications, correspondence, observation records, and the testimony of differently positioned participants. It could then identify feasible alternative rules and estimate their consequences through institutional comparison, controlled intervention where ethically permissible, or counterfactual analysis. Particular attention should be paid to changes in whose communications were recorded, whose objections altered decisions, who supplied resources for continuity, and who bore consequences when the initial arrangement failed. These observations can distinguish formal consultation from influence and protective justification from demonstrable reduction of particular risks.

Research should also examine alternative explanations. A highly restrictive protocol may reflect a documented, proportionate safety requirement; a seemingly permissive one may rely on unacknowledged costs borne by participants without effective voice. Exit possibilities may depend on technological incompatibility rather than intentional exclusion. Institutional concentration may result from fixed costs, specialization, or legal duties as well as strategies to preserve advantage. The GR approach gains analytical value only if tracing heterogeneous productive conditions and their allocation clarifies a mechanism that conventional institutional, economic, and governance analyses leave insufficiently specified.

Finally, initialization power and normative formation remain distinct research objects. An institution can control the conditions under which potential participants first meet even where the subsequent evolution of their expectations and norms is uncertain. Conversely, participants may create new practices within an initially unequal arrangement without thereby legitimating the allocation of authority that established it. The present section therefore identifies control over *entry*, *interpretation*, *exposure*, and *revision* as a political-economic configuration whose consequences require case-specific evidence and normative examination. It prepares the subsequent comparison with multispecies governance and the extraterrestrial power reversal while preserving the distinction between effective control, possible cooperation, and legitimate authority.

10 Multispecies Governance and the Extraterrestrial Reversal

Relations among differently constituted forms of life provide a demanding comparison for a generative-relational (GR) political economy. Human institutions alter habitat, regulate resource flows, organize care, and create technical means of observing other living beings, while those beings participate in ecological processes on which human and nonhuman activities depend. Governance of such relations there-

fore concerns the organization of material coexistence and the distribution of authority to alter its conditions. This section first characterizes coexistence through differentiated conditions of production and reproduction, then examines conservation, representation, and value in terrestrial arrangements. It uses a hypothetical encounter with a technologically more capable extraterrestrial civilization as a bounded reversal of familiar asymmetries of control. Finally, it develops comparative tests for institutional responsibility and identifies the limits of analogy across humans, other terrestrial beings, artificial systems, and possible extraterrestrial interlocutors. The method combines political-economic interpretation, existing multispecies scholarship, institutional examples, and explicit counterfactual reasoning. Extraterrestrial life and its conduct remain unspecified possibilities, and the analysis makes no ontological claim that all these participants possess equivalent forms of agency or moral status.

10.1 Coexistence as the Organization of Differentiated Reproductive Conditions

The coexistence of heterogeneous participants depends on conditions that differ in kind as well as in scale. People require food, water, social care, shelter, institutional continuity, and access to infrastructures through which they sustain particular forms of activity. Nonhuman animals require species- and population-specific conditions for feeding, movement, social interaction, reproduction, and protection from harmful exposure. Other organisms participate in ecological relations that support their continuity under changing conditions. Artificial services require compute, energy, maintenance, material extraction, organizational labor, and functioning interfaces; whether any particular artificial system warrants the term *subject* in a stronger philosophical sense remains open. These conditions overlap through land, water, energy, infrastructure, habitats, and labor, yet they cannot be reduced to a homogeneous inventory of needs.

A GR political-economic description begins with the concrete practices through which participants maintain, transform, or lose capacities in relation to one another. Consider a wetland used for agriculture, freshwater provision, migratory habitat, and ecological observation. A change to water management can improve an agricultural outcome while altering the reproduction of a plant community, breeding opportunities for particular animals, and the livelihoods or cultural practices of people associated with the wetland. The resulting configuration is more precise than a generic conflict between “human interests” and “nature.” It involves several materially situated relationships, capacities, and decision structures, some of which mutually support one another while others compete for the same conditions.

Research on social–ecological systems emphasizes the biosphere as an enabling condition for human social and economic life and investigates how coupled ecological and social processes can transform under disturbance [15]. The 2019 IPBES global assessment documents the importance of human-induced changes in biodiversity and the effects of the production and consumption of resources [26]. Those bodies of work establish significant ecological and institutional research contexts. The further GR proposal is to trace *which participant or organization can reshape the conditions under which other participants generate further activity*, and to identify the distribution of the maintenance, opportunity, and risk burdens involved. This analysis concerns effective control over reproductive conditions, whereas ecological assessment separately provides evidence about biological states and processes.

A useful distinction is between *co-presence*, *functional interdependence*, and *governed coexistence*. Co-presence denotes occupation of partially overlapping environments; functional interdependence denotes causal links between the participants’ continued activities; governed coexistence denotes a configuration in which rules, practices, or infrastructures shape those links. Such governance may be legal and deliberate, customary and distributed, or embedded in technical operations. It may include protective restrictions, commercially organized access, ongoing reciprocal practice, or coercive exclusion. Describing an interaction as governed does not presuppose a unified governor or a shared intention among the beings affected.

Coexistence is therefore a condition to be investigated rather than an outcome automatically certified by proximity or short-term survival. An apparent equilibrium could depend on subsidies, habitat fragmentation, compulsory behavioral adaptation, or displaced ecological costs. Conversely, transfor-

mations that initially disturb familiar arrangements may contribute to better conditions for some affected populations. A political-economic evaluation requires evidence about who benefits, who bears the burden of adjustment, how reproductive possibilities change, and whether participants with decision-making capacities can challenge the organizing rules. Where direct communication is absent, biological monitoring and ethically constrained interpretation acquire particular importance.

10.2 Conservation, Resource Access, and the Distribution of Governance Authority

Conservation supplies a comparatively well-developed institutional setting for examining the difference between protective intentions and the distribution of practical authority. Protected areas, wildlife management, habitat restoration, and species recovery can sustain vital ecological conditions. Their establishment can also alter access to land, customary practices, livelihoods, and decision-making powers. The relevant political-economic question is which arrangements make ecological protection effective while distributing its responsibilities, benefits, and authority in ways that can be justified to affected human communities and assessed for affected nonhuman populations.

The Kunming–Montreal Global Biodiversity Framework offers an explicit institutional point of reference. Its Target 3 calls for conservation of at least 30% of terrestrial and inland-water areas and at least 30% of marine and coastal areas by 2030, accompanied by commitments to effective management, ecological representativeness, connectivity, equitable governance, and respect for the rights of Indigenous peoples and local communities. Target 22 addresses participation in biodiversity-related decision-making and access to information and justice, including recognition of the rights and knowledge of Indigenous peoples and local communities [8]. These targets articulate governance commitments. Their existence provides neither evidence of implementation in a particular locality nor a guarantee that every ecological interest will be represented successfully.

The targets demonstrate why a protected territory cannot be evaluated solely by its mapped area. The allocation of territorial authority shapes permitted activities, resource collection, monitoring, enforcement, and available modes of livelihood. Ecological effectiveness, compliance with relevant rights, public participation, and distributive consequences are related but distinguishable matters. A regime could perform well on a narrow biodiversity indicator while imposing unjustifiable losses on a community. Another could provide elaborate consultation without securing the ecological processes for which protection was established. A sound comparative study therefore examines the histories of land use, customary governance, conservation outcomes, benefit distribution, and processes available for appealing or correcting decisions.

The conventional distinction between insiders and outsiders also requires local specification. Residents may be represented as the beneficiaries of conservation while other groups with historical or seasonal connections to the area are treated as external claimants. Particular species may be designated as conservation priorities, while other organisms are classified principally as threats or inputs to management. Such classifications can be supported by sound ecological evidence in specific cases, yet the criteria for selecting objectives and authorizing interventions have distributive effects. The analyst should document who set the objectives, what evidence they used, how alternatives were compared, and which affected parties can demand explanation or adjustment.

A hypothetical coastal restoration project illustrates the allocation problem. Public agencies may fund replanting and restrictions on harvesting, local organizations may supply ecological knowledge and maintenance, fishing households may absorb opportunity costs, and wildlife populations may experience changed habitat conditions. Several forms of value are created or preserved under such an arrangement, while only some enter a monetary ledger. The project could distribute its long-term authority through local stewardship agreements and independent ecological review, or concentrate decisions in a single implementing body. Which arrangement performs better depends on the empirical configuration, the available alternatives, and the norms that the relevant institutions can justify. The example functions as a research design rather than a reported case or a general policy prescription.

These considerations connect multispecies governance to material political economy. Protective in-

frastructures require labor, energy, equipment, funding, knowledge, legal enforcement, and social trust. Their maintenance may be delegated to actors with limited capacity to change the underlying rules. Conservation success may consequently depend on long-term forms of labor and ecological reproduction whose contribution is poorly captured by the immediate distribution of money or formal decision rights. The GR inquiry adds the question of how access to these generative conditions is produced, allocated, and kept open to revision.

10.3 Representation, Legal Personality, and Epistemic Mediation

Multispecies governance confronts an institutional difficulty: the beings most directly affected by a decision may have limited access to human legal and communicative procedures. Animals can express behavior relevant to welfare, preference, and environmental suitability, while ecological communities can exhibit measurable changes in composition and function. Interpreting such evidence requires particular biological knowledge and an acknowledgment of scientific uncertainty. Formal political representation, however, depends on procedures for selecting representatives, defining a mandate, reviewing conduct, and correcting mistaken judgments. These requirements remain distinct from the question of whether a researcher can infer a biological effect with reasonable confidence.

Meijer's multispecies social-connection model offers a relevant theoretical precedent by linking structural injustice affecting animals to political and economic entanglements, while attending to animal agency and questioning human-centered accounts of responsibility [30]. The present analysis shares that concern with structures of participation and control. It further asks whether the institutions that produce relevant evidence, maintain habitats, and authorize consequential classifications are controlled by the same actors who gain from the activities being assessed. Potential conflicts may arise when an operator responsible for development also determines which ecological observations qualify as actionable harm, or when a proxy representative depends financially on the project being reviewed.

A distinct legal example is provided by Aotearoa New Zealand's Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. The Act recognizes Te Awa Tupua in terms that encompass the Whanganui River as an indivisible and living whole, establishes its legal personality, and provides for Te Pou Tupua to exercise the legal person's powers and duties on its behalf. The statutory framework also includes collaborative governance and funding provisions [49]. These are specific legal and institutional developments associated with the history and relationship of Whanganui Iwi and the river. Their significance is historically situated and cannot be captured adequately by treating the example as an abstract grant of rights to an interchangeable natural object.

This example clarifies three analytically separate questions. The first is *juridical recognition*: whether an entity has a defined status in a particular legal order. The second is *mediated authority*: who may exercise specified powers, with what duties, and through what accountability arrangements. The third is *ecological or relational consequence*: whether the institutional arrangement contributes to the maintenance of the river's relevant relations and to the rights and practices implicated in its governance. Legal personality addresses the first question in a particular way and structures aspects of the second. Its ecological achievements must be investigated through additional evidence. The legal category itself establishes neither a scientific finding about sentience nor an ultimate ontology of the river.

The GR research programme can use such cases to distinguish several forms of representation. *Delegated representation* rests on an identifiable mandate from a capable principal. *Protective representation* involves an institution charged with advancing specified interests of an affected participant who cannot authorize the representative through the ordinary procedure. *Epistemic mediation* involves scientific, experiential, or interpretive work that translates evidence into a decision setting. *Institutional trusteeship* can combine elements of these forms under enforceable duties. Their validity depends on different justifications, and a single actor may hold overlapping roles that merit scrutiny.

For organisms or systems lacking established channels of consent, claims to know what they "want" require special restraint. Multiple indicators, independent review, records of uncertain interpretation, and repeated evaluation can reduce certain errors. A transparent account should identify the chosen unit of

concern—an individual animal, a population, an ecosystem process, a watershed, or a group of affected human and nonhuman relations—because these units can exhibit different and occasionally conflicting patterns. Uncertainty about representation need not lead to governance paralysis; it does require clearer procedural responsibility for interpretation, for correction, and for the risks of mistaken intervention.

10.4 Plural Value and the Political Economy of Ecological Return

The diversity of ecological and cultural relations also challenges attempts to express multispecies governance through one measure of aggregate benefit. Habitat continuity, subsistence, income, animal welfare, cultural relationships, biodiversity, and ecological resilience may be assessed through different kinds of evidence. Their significance can vary among communities and across specific sites. The IPBES assessment of the diverse values and valuation of nature identifies multiple approaches and perspectives and is directly relevant to the practical difficulties of evaluation under value plurality [27]. Its treatment of value offers an established context; the GR argument remains a separate, preliminary interpretation of how those evaluations relate to control over productive conditions.

A political-economic inquiry should distinguish the production of a benefit, its appropriation by an actor, and the conditions under which affected relationships can reproduce. Ecological contributions to agriculture may support a commercial return while maintenance of the relevant ecosystem falls upon a different community or public institution. Conservation tourism may generate revenue for one organization while leaving local maintenance work weakly compensated. A research infrastructure may collect valuable environmental data while limiting the ability of those supplying knowledge or land access to influence reuse. Each scenario admits alternative interpretations and requires its own evidence. The common object of inquiry is the arrangement through which different forms of contribution become captured, distributed, reinvested, or depleted.

Ecological return, in the limited analytical sense proposed here, refers to the identifiable ways in which benefits, resources, protections, or decision capacities produced through a relation are directed toward sustaining or improving the conditions that support that relation. The term is a research descriptor, rather than a new universal currency or an assertion that nature expects reciprocal exchange in human institutional terms. Examples could include maintenance of habitat connectivity after resource extraction, funded restoration attached to a productive activity, or sustained decision authority for communities whose knowledge enabled conservation. Such mechanisms differ substantively; an analyst should avoid treating them as interchangeable merely because they can each be called “return.”

One implication concerns *the location of regenerative responsibility*. An institution may claim a positive ecological balance on the basis of immediate output measures while assigning waste management, biological monitoring, or future repair to others. Its calculation may be methodologically defensible for one specified output and incomplete for assessing the whole configuration of dependence. A GR account would identify whose continued capacities are included, the timescale of observation, and the institutional authority to alter the conditions of reproduction. This remains compatible with quantitative accounting where units and boundaries are defensible, and with qualitative or plural assessments where commensuration would obscure consequential differences.

Another implication concerns the politics of substitution. Replacing one wetland with a different restored habitat, or one culturally significant landscape with financial compensation, may be proposed as a balance of benefits and losses. Such a proposal presupposes judgments about ecological function, location, historical relationships, and acceptable replacement. Some effects may be measurable across sites; others depend on situated relations and institutions whose preservation carries a distinct normative significance. The relevant question is therefore which substitutions are justified under specified ecological and social criteria, who authorizes them, and how uncertainty is borne. This argument neither rejects valuation nor grants any valuation technique unrestricted authority.

2275 10.5 The Extraterrestrial Reversal as a Comparative Test of Power

2276 The *extraterrestrial reversal* is a thought experiment in which human societies confront a hypothetical
2277 civilization possessing substantially greater technical capacity to reshape the conditions of interaction.
2278 The scenario reverses a familiar position in which humans control observation, habitat, access, or inter-
2279 vention affecting other terrestrial beings. Its analytical function is to examine the consistency of political-
2280 economic and normative judgments across an asymmetry of capability. It is deliberately silent about the
2281 existence, intentions, biological organization, rights, or institutions of extraterrestrial life. A hypotheti-
2282 cal civilization could have distinct internal divisions, with institutions and participants that differ among
2283 themselves; superiority in a particular technical domain would provide little information about those
2284 other attributes.

2285 Suppose, as a stipulated scenario, that an external civilization offers human communities medical
2286 technologies, clean energy systems, or protection against environmental hazards. The offer could ex-
2287 pand practical human capabilities. It might also require exclusive use of external infrastructure, accep-
2288 tance of opaque behavioral monitoring, and relinquishment of human authority over future modifications.
2289 Another hypothetical arrangement could make technical knowledge locally reproducible, permit indepen-
2290 dent verification, support plural human governance, and provide practical means for ending cooperation.
2291 The difference lies partly in benefits delivered and partly in the dependence created by the terms under
2292 which the benefits can be maintained.

2293 The first comparison concerns *competence and authority*. Superior predictive or technical capacity
2294 might justify giving great weight to an interlocutor's evidence on a specific problem. It does not, by
2295 itself, settle the interlocutor's political mandate to determine another population's acceptable future. The
2296 same distinction applies when humans invoke expertise in governing animals, ecosystems, or groups with
2297 unequal access to specialized knowledge. Differences in the kinds of agency and rights at stake remain
2298 substantial; the thought experiment tests the justificatory move from capability to authority rather than
2299 asserting that these cases are morally identical.

2300 The second comparison concerns *benefit and dependence*. A community could enjoy considerable
2301 gains while its range of independently feasible practices contracts. Conversely, reliance on shared in-
2302 frastructure may be acceptable where obligations, continuity, mutual constraint, and revision rights are
2303 sufficiently established. An assessment of dependence should therefore consider the availability of alter-
2304 native sources of knowledge and material support, retained capacities for maintenance, the distribution
2305 of decision rights, and the effects of withdrawal. Consent matters, yet nominal acceptance under extreme
2306 asymmetry of information and feasible alternatives deserves contextual evaluation.

2307 The third comparison concerns *protection and paternalism*. One civilization may be better able to
2308 detect and mitigate a risk that another does not understand. Protective restrictions can be warranted
2309 when they respond to credible hazards and have a defensible scope. They can also enable persistent
2310 discretionary control unrelated to the identified risk. A more demanding justification would specify the
2311 hazard, the evidence for intervention, the least burdensome effective available options, the duration and
2312 review conditions, and the channels through which affected participants can acquire greater competence.
2313 This comparison sharpens the parallel question in terrestrial conservation: effective ecological protection
2314 and an accountable distribution of authority require related but separate judgments.

2315 The fourth comparison concerns *representation under internal heterogeneity*. Human institutions
2316 might present themselves to an external interlocutor as authorized speakers for humanity, even though
2317 the preferences, rights, and material circumstances of human populations differ substantially. Their
2318 mandate could be limited, disputed, or absent. Nonhuman terrestrial life would also be affected by many
2319 imaginable interventions while remaining outside conventional diplomatic representation. Accordingly,
2320 the power reversal does not create a unitary "human interest." It exposes a layered representation problem
2321 involving states, local communities, scientific institutions, other species, and possible future generations,
2322 with distinct sources of legitimate authority and incomplete channels of consultation.

2323 A strong version of the thought experiment leaves the hypothetical superior civilization's moral mo-
2324 tivations unspecified. It asks whether the legitimacy of an arrangement can be assessed by examining
2325 decision rights, evidence, obligations, and feasible alternatives even when its participants disagree about

Table 9: Political-economic dimensions of multispecies coexistence and the hypothetical power reversal

Analytical dimension	Terrestrial evidence or institutional question	Reversal test under stipulated superior capability
Reproductive conditions	Habitat, livelihoods, ecological processes, maintenance and exposure records	Which human capabilities remain independently reproducible?
Technical advantage and discretion	Authority over monitoring, ecological intervention, infrastructure and enforcement	Does superior competence become unilateral control over policy?
Plural valuation	Conservation outcomes, cultural values, welfare measures, benefit distribution	Who defines the benefits used to justify an offered intervention?
Representation and interpretation	Legal mandates, scientific uncertainty, local and Indigenous participation, proxy roles	Which institutions could credibly speak for differently affected humans and other life?
Continuity and exit	Restoration obligations, switching costs, risk-sharing and alternate livelihoods	Can recipients maintain gains and end the arrangement without disproportionate loss?
Evidence and revision	Independent monitoring, corrective procedures, funding and review records	Can the less powerful party contest claims and change operative rules?

ultimate values. The answer can only be partial. Some shared procedural standards may be proposed for investigation, including disclosure of consequential conditions, opportunities for independent observation, and mechanisms for revising imposed burdens. However, there is no established universal diplomatic framework for such an encounter, and an unfamiliar civilization might lack institutions analogous to contract, representation, or human communication. At that boundary the scenario functions as a test of our concepts rather than an empirical model of encounter behavior.

10.6 Institutional Configurations under Unequal Capability

To make the reversal analytically useful, the comparison should examine several feasible institutional configurations rather than classify all technically unequal relations as equivalent. Imagine four stylized arrangements. Under *extractive administration*, the technically advantaged participant controls vital infrastructure and takes resources or information while the less advantaged population has narrow corrective options. Under *protective dependency*, substantial welfare gains coexist with persistent concentration of essential maintenance and rule-revision authority. Under *negotiated interdependence*, parties develop shared or interoperable capacities, limits on discretionary control, and credible processes for altering their agreement. Under *separated coexistence*, actors restrict interaction or maintain protected boundaries because available cooperative arrangements impose unacceptable risks or burdens. These are interpretive ideal types rather than exhaustive or mutually exclusive categories.

The ideal types reveal an important ambiguity: increased productive capacity can coexist with reduced political discretion, and institutional separation can be either protective or exclusionary. A community may rationally accept a dependency where alternative material conditions are severe. A jointly governed arrangement may still conceal power through control of underlying maintenance, testing, or interpretive standards. A refusal of contact may protect vulnerable relations while limiting beneficial exchange. The evaluation cannot be determined from the category alone; it requires a historically and materially specific account of the available options and the consequences borne by different participants.

Table 9 proposes a comparative register for examining these arrangements across grounded terrestrial cases and the hypothetical reversal. The rows identify evidence to pursue rather than a scoring system with a common utility unit. Its use in a counterfactual extraterrestrial scenario remains conceptual, while the terrestrial entries can guide empirical inquiry.

The register makes a proposed *position-reversal diagnostic* more precise. When an intervention is defended as legitimate because one participant is stronger, better informed, or able to confer benefits, the analyst can reconstruct an analogous argument with the distribution of those properties inverted. If the justification changes, the inquiry should identify the premise responsible for the difference. Some differences will be defensible: a human legal entitlement differs from a conservation duty toward a

particular species, and an ecosystem's functioning differs from an individual human preference. Other changes may expose unexamined presumptions that greater power alone confers authority to choose another participant's reproductive conditions. The diagnostic is a method for interrogating arguments, not a theorem of moral equivalence across species or civilizations.

The comparison can also clarify the relationship between institutional trust and control. Repeatedly beneficial conduct may provide evidence that a provider can perform promised functions. Trustworthiness concerning the governance of dependence additionally requires reliable limits on the power to revise obligations, with practical forms of review and repair. These two dimensions can diverge. A technologically capable agent may provide indispensable services while retaining broad unilateral discretion; an imperfect institution may retain stronger checks on that discretion. Whether either arrangement is acceptable is a further normative and empirical question. G2's contribution is to make the distinct dimensions available for examination.

10.7 Comparative Research Design and the Limits of Analogy

A comparative research programme could examine terrestrial cases in three stages. First, reconstruct the ecological and institutional history of an interaction through biological records, land and resource-use histories, contracts, legal instruments, local knowledge, and budgetary evidence. Second, identify the material and interpretive channels through which particular organizations influence the activity or continued reproduction of affected populations and environments. Third, compare feasible institutional alternatives, observing changes in ecological outcomes, practical decision influence, distribution of costs, maintenance responsibilities, and access to correction. The inquiry should distinguish evidence of improved outcomes from evidence of an accountable procedure: each may be present without conclusively establishing the other.

For example, a study of watershed governance could document how river condition is assessed, who exercises legally specified powers, and whether designated representatives have resources and authority to influence management. The Te Awa Tupua framework offers a legal source for developing such questions, with case-specific historical and ecological evidence required to answer them [49]. A comparative study of conservation territories could investigate how ecological criteria and community rights are represented in decision records, using the biodiversity framework's targets as articulated public commitments rather than achieved benchmarks [8]. A study of human-operated AI environmental monitoring could assess whether the data, maintenance work, and decisions remain contestable by communities subject to the resulting conservation policies. These are prospective designs, without a claim that the proposed comparisons have already been carried out.

Several limitations constrain cross-case interpretation. Species, populations, ecological processes, legal persons, and artificial systems are different analytical units. A river's legal personality arises from a particular legal and historical settlement; it carries different implications from scientific evidence about an animal's welfare or a human community's delegated mandate. Evidence of animal agency, where established, warrants attention in its own terms and does not entail assumptions about technological communication or contract-making. Artificial services exhibit other production and accountability structures, and current observations give insufficient grounds to assign them the moral status of human or nonhuman animal subjects as a class. Comparisons should preserve these differences in the definition of interests, identification of agents, and evaluation of harms.

The extraterrestrial scenario has a further asymmetry of evidence. Terrestrial governance can be investigated using legal and institutional records, environmental observation, and the testimony of people affected. A technologically superior extraterrestrial interlocutor is a stipulated construction, so claims about its institutions, intentions, communication, or values lack observational grounding. The reversal can expose hidden assumptions in an argument about power and legitimacy, but empirical conclusions drawn from terrestrial cases cannot be transferred to it. The strength of the exercise rests on transparent stipulations and the ability to identify exactly which political-economic propositions survive their reversal.

A final limitation concerns time and change. Ecological feedback, institutional learning, population dynamics, and infrastructure maintenance unfold at different rates. A governance arrangement may improve an observable indicator during one observation period while generating deferred liabilities for another. An apparent consensus may likewise reflect who could participate during a particular institutional interval. These are model-relative observation windows within evolving relational histories, without an ontologically privileged present or a presumed linear endpoint. Subsequent analysis should attend to delayed consequences and the continuing availability of corrective capacity rather than assign permanence to an initial classification.

The central implication is a conditional one. Where actors have unequal capacity to shape another participant's generative conditions, the assessment of coexistence benefits from separating material capability, effective control, plural value, representative authority, and the institutional means for correction. Terrestrial multispecies arrangements make these dimensions observable in partially different ways; the extraterrestrial reversal probes the consistency of the reasoning used to justify them. Together they suggest a research programme on *governed interdependence under heterogeneous conditions* in which productive gains are evaluated alongside who maintains their possibility and who can challenge the rules of their distribution. This provides a substantive bridge to the preliminary formal account of relational dependence in the planned section on the formal account of relational dependence, where feasible practices and interventions will be represented under stated assumptions and without a universal value metric.

11 A Preliminary Formal Account of Relational Dependence

A preliminary formal account can clarify which political-economic differences remain visible when heterogeneous participants are described through the practices available to them and the conditions under which those practices can continue. Its immediate purpose is analytical: to distinguish a participant's feasible practices from its observed conduct, another participant's capacity to alter those practices from the legitimacy of doing so, and short-range access from the reproduction of capacities over a specified interval. This section constructs a minimal set-based representation of these relations, examines interventions and dependencies, introduces a conditional criterion for continued practice, and derives a limited implication about institutional restrictions. It then works through stylized human–AI and ecological examples before specifying possible observations and model failures. The method is structural and counterfactual, with concepts adapted to empirical inquiry rather than offered as an ontological model of every kind of subject. None of the definitions presupposes a common utility metric, identical agency across human and nonhuman participants, or a universal account of what constitutes flourishing.

11.1 Configurations and the Conditional Feasibility of Practices

Consider a finite collection I of analytically distinguished participants or affected units. A unit may be an individual, an organization, a population, or a specifically defined ecological process, according to the research question. Such indexing does not assign identical capacities to all units. Where the unit is a river, an animal population, or a technical service, a “practice” may designate an observable mode of functioning or an interaction that can be sustained under specified conditions; it need not designate deliberate choice. Where the unit is a human person or institution, the relevant alternatives may include actions involving interpretation, refusal, organization, and political participation. The types and boundaries of the units therefore require domain-specific explanation.

For each $i \in I$, let A_i be a repertoire of distinguishable practices at a specified spatial, temporal, and descriptive resolution. Let a configuration $c = (x, \pi, h)$ comprise three components. The term x records selected material and infrastructural conditions, including spatial constraints, resource availability, maintenance arrangements, and technical capacities. The term π records institutional and interface conditions, such as access permissions, enforceable obligations, property relations, protocols, and decision procedures. The term h records relevant relational histories and the analyst's warranted assumptions about coordination and responses by others. This last component matters because an option that is phys-

ically imaginable can remain practically inaccessible when complementary actions, information, labor, or permission are unavailable.

Let $\mathcal{J}(c)$ be the set of jointly attainable practice profiles under the conditions represented by c . The joint set is a constrained subset of $\prod_{i \in I} A_i$. Its construction must respect the interaction among participants, rather than independently listing what each could do in isolation. The projected feasible repertoire for participant i is defined in Equation 2.

$$\mathcal{F}_i(c) := \text{pr}_i \mathcal{J}(c) = \{a_i \in A_i : \exists a_{-i} \text{ with } (a_i, a_{-i}) \in \mathcal{J}(c)\}. \quad (2)$$

Equation 2 makes feasibility explicitly relational: the availability of an i -practice depends on at least one attainable configuration of the practices of other units. Its existential condition nevertheless requires caution. If $\mathcal{J}(c)$ contains technically compatible profiles without adequately accounting for bargaining, coordination, or unequal enforcement, the projection will exaggerate access. The researcher should therefore specify whether $\mathcal{J}(c)$ represents physical possibility, legal permission, institutionally credible access, or a narrower empirically supported notion of attainability. These distinct levels can be compared, but an assertion about one level does not establish an assertion about the others.

The distinction between a repertoire and an outcome is also essential. A realized observation a_i^{obs} may belong to $\mathcal{F}_i(c)$ while providing very limited evidence about the remaining elements. Repeated performance of one task cannot by itself establish the range of alternatives, their cost, or their sustainable reproduction. Conversely, the availability of several nominal options says little about whether they are substantively different, equally accessible, or compatible with the unit's continued functioning. Identifying A_i and $\mathcal{J}(c)$ is consequently a demanding empirical and interpretive task, rather than a simple extraction of a list from behavioral records.

Configurations can be indexed by observation windows and relational settings without supposing that one instant constitutes an ontologically privileged present. Changing practices, material conditions, and institutions may also alter the descriptive categories in A_i . Direct set comparison then requires an explicit translation or correspondence between categories across configurations. Where a stable mapping is unavailable, the inquiry should report partial comparability and preserve the conceptual remainder rather than treating its categories as invariant by definition. This restriction will be particularly important in historically distant, cross-species, and hypothetical extraterrestrial comparisons.

11.2 Intervention, Discretion, and Asymmetric Influence

Relational dependence becomes politically consequential when certain participants can selectively transform conditions affecting the feasible practices of others. For a potential controller j , let $U_j(c)$ designate the interventions that j can effectively carry out under configuration c . The set may depend on ownership, access credentials, labor relations, technical skills, collective authorization, or coercive capabilities. These sources should be separately identified. Let $T_j(c, u)$ denote a stipulated or empirically reconstructed configuration following intervention $u \in U_j(c)$. The notation permits an intervention to change material conditions, institutional rules, coordination arrangements, or several of them together. A deterministic transformation is used here for clarity; uncertainty can later be represented through a correspondence or a distribution over possible resulting configurations.

The change in participant i 's feasible repertoire can be represented as two sets rather than a signed numerical score. Equation 3 defines practice gains and practice losses relative to the specified baseline configuration.

$$\begin{aligned} G_{j \rightarrow i}(u \mid c) &:= \mathcal{F}_i(T_j(c, u)) \setminus \mathcal{F}_i(c), \\ L_{j \rightarrow i}(u \mid c) &:= \mathcal{F}_i(c) \setminus \mathcal{F}_i(T_j(c, u)). \end{aligned} \quad (3)$$

The pair in Equation 3 retains a simple but important feature of heterogeneous political-economic relations: the same intervention can enable certain practices and close others. A supplier may improve access to computation while making independent migration more difficult. A habitat-management intervention may restrict one form of resource extraction while supporting other ecological processes. Even within one participant, the sets of gains and losses do not establish an overall welfare ranking without

additional evaluative assumptions. Between differently constituted participants, a common ranking may be particularly inappropriate. Empirical work should record concrete changes in activities, capacities, and burdens before considering whether a particular normative evaluation is defensible.

A related concept concerns the extent of discretionary influence. Equation 4 represents the family of feasible repertoires that controller j could bring about for unit i using interventions available in the model.

$$\mathcal{D}_{j \rightarrow i}(c) := \{ \mathcal{F}_i(T_j(c, u)) : u \in U_j(c) \}. \quad (4)$$

When the family in Equation 4 contains meaningfully different members, the model assigns j the capacity to alter i 's practical alternatives. Such influence may operate through ordinary cooperation, contract enforcement, shared governance, exclusive control, or threats of withholding an essential service. The size or diversity of the family alone does not determine the power relation's ethical standing. The authority to exercise discretion, the availability of checks, the actual use of the intervention, the presence of alternatives, and the consequences of refusal require independent investigation. Emerson's relational analysis of power and dependence motivates attention to alternatives and the conditions of dependence, while institutional analysis situates those alternatives in concrete rules and action settings [13, 36]. The displayed construction is a proposal within G2 and is not attributed to those authors.

It is also necessary to distinguish a deliberately exercised capacity from an effect produced without effective choice. A material event may eliminate practices even when no identified actor controls it. A decision-maker may formally authorize an intervention while possessing little discretion because another institution controls its necessary resources. Conversely, a platform operator may exercise effective technical control while the legality or legitimacy of the action is disputed. The domain $U_j(c)$ should therefore be accompanied by an account of decision rights, de facto enforcement, joint dependencies, and whether alternative interventions were credibly available. Where several actors must act together, the unit of analysis may be a coalition with a specified decision procedure; attributing the resulting capacity to each member individually would overstate unilateral power.

11.3 Withdrawal Dependence and the Reproduction of Capacities

The loss of an option through a feasible withdrawal supplies a narrower test of dependence. Suppose $w_j \in U_j(c)$ is a specified intervention by which j withdraws an input, permission, service, or coordination contribution. The relevant question is which practices of i cease to be attainable under that intervention, allowing for any adjustments and substitutions that are included in $T_j(c, w_j)$. The withdrawal-sensitive part of the baseline repertoire is stated in Equation 5.

$$\mathcal{W}_{i|j}(c; w_j) := \mathcal{F}_i(c) \setminus \mathcal{F}_i(T_j(c, w_j)). \quad (5)$$

A nonempty $\mathcal{W}_{i|j}(c; w_j)$ identifies a conditional loss of possibilities. It does not show that every practice of i depends on j , that i is unable to survive without j , or that j possesses unqualified bargaining power. A replacement service, collective provision, technical adaptation, or an independent resource may preserve some or even most alternatives. Conversely, a relatively small set of lost practices may contain a critical capability needed for another activity. Research should therefore identify the affected practices, their substitutability, and the conditions required to realize substitutes, as well as the resources expended during reconfiguration. Hirschman's distinction between exit and voice remains helpful for analyzing responses to organizational deterioration, while the present construction asks what makes a purported exit materially feasible [22].

Reproductive dependence calls for a more temporally extended description. Fix a finite observation or planning horizon H appropriate to the system under study. Let $\mathcal{F}_i^H(c)$ be the set of attainable trajectories of practices of i over that horizon, considering resource renewal, infrastructure maintenance, ecological feedback, and institutional responses as relevant. Let K_i^H be a separately justified set of trajectories satisfying a stated criterion of continued functioning, protected opportunity, or reproductive capacity. For a human worker the criterion might involve maintaining access to livelihood-generating work under stated employment and resource assumptions; for an ecological population it might involve

a scientifically specified measure of demographic or habitat continuity; for a technical service it might involve operational continuity under maintenance constraints. These are different, locally chosen criteria with different sources of evidential and normative authority. Equation 6 defines their intersection.

$$\mathcal{C}_i^H(c) := \mathcal{F}_i^H(c) \cap K_i^H. \quad (6)$$

Within the model, a configuration has an attainable trajectory satisfying the selected continuity criterion precisely when $\mathcal{C}_i^H(c)$ is nonempty. The comparison between $\mathcal{C}_i^H(c)$ and $\mathcal{C}_i^H(T_j(c, w_j))$ can reveal a stronger form of conditional dependence when the former is nonempty and the latter is empty. This remains a conclusion relative to H , K_i^H , the represented alternatives, and the assumed responses to withdrawal. In particular, empty modeled continuity sets can reflect omitted adaptive possibilities or poor measurement. A long planning interval can conceal short-run hardship, while a short interval can conceal cumulative depletion. The analyst should therefore examine several empirically defensible horizons where evidence permits.

The reproduction of capacity is also distinct from the continued production of a particular output. An AI-mediated service may maintain its performance through greater human maintenance work, higher energy expenditure, or greater concentration of organizational control. A habitat-management project may temporarily meet an ecological indicator while imposing unmeasured maintenance or livelihood burdens on neighboring communities. The continuity description should make the relevant inputs and liabilities visible, including who supplies them and who can discontinue or alter their provision. Research on the material dependence of AI services, including energy requirements of data-centre operations, provides a reason to trace such conditions beyond a model's visible responses [24]. This reference documents an important domain of material infrastructure; it does not validate a particular G2 continuity function.

11.4 Institutional Restriction and the Limits of Set Inclusion

A modest formal implication follows when a new rule simply narrows the set of jointly attainable profiles while all other represented conditions remain fixed. The premise is deliberately restrictive. Institutions frequently induce learning, investment, substitution, and ecological feedback, which can change the underlying set of attainable configurations as well as the permissions imposed upon it.

Proposition 11.1 (Projection under a restrictive change). *Let c and c' be configurations for which the participant sets and practice repertoires are identified through a common description. If $\mathcal{J}(c') \subseteq \mathcal{J}(c)$, then $\mathcal{F}_i(c') \subseteq \mathcal{F}_i(c)$ for each $i \in I$.*

Proof. Every profile in $\mathcal{J}(c')$ also belongs to $\mathcal{J}(c)$. Its i -component therefore belongs to the projection of $\mathcal{J}(c)$. Taking all such components yields the stated inclusion. $\square$

Proposition 11.1 is an elementary property of projection, rather than a substantive economic law. It clarifies what can be concluded if a change acts solely by deleting available profiles from a fixed possibility set. It establishes no judgment about justice, welfare, or long-run productive and ecological outcomes. A temporary restriction on extraction may remove immediate harvest practices while supporting later ecological recovery; a safety constraint may curtail a risky operation while sustaining a different capacity over an extended interval. In either case, the assumption of an unchanged underlying joint set is likely to fail when the longer process is modeled. A suitable inquiry would analyze the revised material conditions and attainable trajectories, rather than claim that the restricted set alone captures the intervention's value.

An apparently protective permission rule can also have different effects depending on implementation. Where access to a process requires an expensive compliance apparatus, an identical written rule can exclude some participants more readily than others. Where a technological intermediary controls the evidence used to demonstrate compliance, its interpretive discretion can enlarge an asymmetry beyond what the rule's text suggests. Such arrangements may be modeled through changed components of x , π , and h , but their causal significance requires documentary, observational, or experimental support. The separation of descriptive feasibility from normative justification is therefore an enabling constraint on the use of the formalism itself.

11.5 Two Stylized Applications across Different Relational Systems

An AI-mediated research infrastructure. Consider a research collective using a hosted AI service for selected tasks while retaining local software and manual review. The hosted service depends on servers, electricity, contractual permissions, technical maintenance, and labor. The collective’s ability to carry out a task depends on more than the model’s response quality: access terms, data portability, available expertise, continuity of service, and the time required to substitute another process also matter. Let the collective’s repertoire distinguish a hosted workflow, a local workflow, and a fully human workflow, each specified with task-quality and resource requirements. The existence of a local workflow in documentation does not establish that it is presently attainable with the collective’s equipment and personnel.

Suppose an operator changes an interface permission that previously allowed extraction of the collective’s own intermediate research records. The immediate gain-and-loss comparison in Equation 3 asks which workflows remain accessible under the changed interface; the discretion family in Equation 4 asks whether the operator had a credible alternative policy within its control. A withdrawal scenario can then examine whether maintained access to the hosted workflow is necessary for a specified research programme during horizon H , or whether local reconstruction can sustain the programme under the relevant resource constraints. A platform policy that enlarges immediate computational capabilities may simultaneously increase later switching burdens; these outcomes should be recorded separately. This is a stipulated analytical example, and actual contractual and technical conditions would have to be examined for any particular platform or institution.

A further comparison would identify who can exercise voice or institutional review: collective members, data contributors, workers, funders, the operator, and persons affected by the research results may have different forms of standing and material leverage. The analytic roles also need to remain precise. The AI service is a technical participant within a sociotechnical network; the description does not depend on treating the model as a conscious political claimant. Its users, maintainers, and institutions are distinguishable centers of responsibility and decision authority. A formal map that merged them into a single “AI actor” would obscure the relevant political economy.

A coastal ecological observation and resource-use arrangement. Consider a hypothetical coastal programme combining habitat restoration, local fisheries, sensor deployment, and robotic environmental observation. Relevant units might include fishing households, a public authority, a robot-service operator, and a defined biological population. The population’s modelled modes concern ecological reproduction or movement, whereas the other units may possess articulated choices about labor, access, oversight, and equipment operation. The joint attainability set includes material compatibility constraints: a vessel route may disrupt observation or habitat protection; a sensor station may need maintenance during a biologically sensitive period; a closure may constrain fishing activity while changing future conditions for population renewal. Scientific uncertainty concerning these effects should be represented rather than suppressed.

A rule that restricts vessel movement might narrow one household’s immediate practices and alter the biological population’s feasible trajectories over a longer horizon. The intervention should be assessed at several levels: the physical effects documented by ecological monitoring, changes in livelihood opportunities, the distribution of maintenance and transition burdens, and the authority to amend or review the rule. A uniform numerical score would require assumptions about commensurability and representation that are additional to the feasibility account. The IPBES assessment of diverse values and valuation approaches offers an external basis for treating ecological valuation as plural and context-dependent [27]. The model itself retains descriptive distinctions and leaves the normative choice among them open for argument.

These examples also expose the risks of analogy. A fishing household’s ability to refuse, an ecological population’s vulnerability to habitat modification, and a platform user’s contractual switching right are constituted through different practical and institutional relations. A shared set-theoretic language can identify constraints, dependencies, and interventions in each case, while its locally defined

Table 10: Provisional operational register for relational feasibility and dependence

Analytical object	Potential observations	Interpretive limitation or rival account
Configuration c	Resource inventories, permissions, infrastructure maps, decision procedures, documented historical constraints	Categories may omit informal cooperation, ecological feedback, and tacit work.
Joint attainability $\mathcal{J}(c)$	Observed coordinated practice, tested alternatives, simulation subject to field validation, interviews	Realized profiles reveal only part of the feasible set; simulations depend on their assumptions.
Intervention $T_j(c, u)$	Rule revisions, interface logs, operational choices, contracts, implementation records	Contemporaneous changes and anticipated adaptation can confound attribution.
Effective discretion $U_j(c)$	Available technical controls, legal authority, governance minutes, evidence of credible alternative decisions	Written powers may lack practical effect; apparent choice may be constrained by others.
Withdrawal-sensitive practices	Outage or access-change events, substitutions, switching costs, interrupted tasks	Short-run disruption may differ from persistent dependence or from deliberate exclusion.
Continuity set $\mathcal{C}_i^H(c)$	Maintenance records, livelihood persistence, population monitoring, resource renewal, alternative horizons	Chosen continuity criteria and observation windows can conceal harms or adaptation.
Cross-unit evaluation	Participant testimony, plural ecological indicators, burden records, corrective outcomes	Distinct interests and valuations may resist faithful conversion to a common measure.

categories and standards preserve their differences. The value of comparison rests in the questions made explicit and empirically discriminating, rather than in a claim that the same mathematical object supplies an exhaustive account of every case.

11.6 Observation Strategies and Rival Explanations

A set-based construction becomes empirically informative when the categories used in it can be traced to evidence and when alternative causal accounts remain testable. Table 10 offers a preliminary register for identifying evidence relevant to configurations, interventions, continuity, and power. It distinguishes the model's proposed objects from the observations needed to identify them and the rival explanations that can weaken a particular inference.

The table invites three complementary empirical approaches. Historical and institutional reconstruction can identify who created an interface, held rights of revision, performed maintenance work, or controlled an alternative resource. Process tracing can compare a documented intervention with changes in practice, recording implementation delays, substitution, and mediation by third parties. Bounded field studies, simulations, or natural experiments may estimate specific feasibility changes where conditions can be compared responsibly. These modes of inquiry answer different questions and can correct one another's omissions. A simulation can test the consequences of assumed resource constraints, while interviews and institutional evidence may reveal dependencies absent from its data model.

Particular care is required in inferring a counterfactual $T_j(c, u)$. An operator who changes an access rule may do so in response to an external security obligation, a technical failure, or strategic market incentives. An ecological intervention may be followed by population recovery because of environmental variation rather than the intervention alone. An organizational withdrawal may cause disruption because necessary preparation was withheld, because substitute resources were intrinsically unavailable, or because participants lacked information about them. A credible causal investigation must consider these alternatives and distinguish observed differences from effects assigned by a structural assumption. When causal identification is weak, the model can still organize questions and document uncertainty without pretending to estimate the effects.

Evidence about feasible choices is particularly difficult where power operates through anticipation. A worker may avoid a complaint because retaliation is expected; a community may cease requesting access after repeated refusal; a small organization may regard a technically available appeal as prohibitively

costly. Official records can then misleadingly suggest that there was little demand for alternatives. Depending on ethics and feasibility, researchers may need confidential testimony, institutional process histories, independent inspection, or controlled testing to assess the credibility of nominal options. Such inquiry also requires precautions against exposing vulnerable participants to additional harm. The concept of a feasible practice should reflect the material and relational conditions of its exercise, rather than the mere presence of a permission in a policy document.

11.7 Formal Scope, Normative Boundaries, and the Subsequent Institutional Inquiry

The proposed formal account is intentionally modest. It supplies a vocabulary for distinguishing practice repertoires, joint constraints, interventions, discretion, withdrawal-sensitive dependence, and continuity under locally justified criteria. It provides one elementary conditional implication, Proposition 11.1, and a comparative register for linking these constructions to evidence. It does not establish a comprehensive causal model, a general equilibrium, a universal measure of freedom or value, or an identity between heterogeneous biological, human, and technical processes. The mathematical representations remain instruments of inquiry, and their categories may be revised or abandoned where empirical and conceptual comparison fails.

Several substantive questions remain open. The availability of a trajectory does not show that its realization would be just. A benevolent use of discretionary power does not itself settle who was entitled to exercise it. The preservation of a particular continuity criterion may demand sacrifices borne by other participants, and the decision to privilege that criterion requires public, legal, ecological, or moral reasoning specific to the setting. Outcomes, responsibility, authority, and the adequacy of representation therefore remain separately assessable. These boundaries are especially significant where researchers speak about the interests of nonhuman populations or possible artificial subjects: a descriptive formalism cannot establish their moral standing or provide an authorized voice on their behalf.

For institutional comparison, the central questions are consequently practical and revisable. Which feasible practices depend on an actor's discretion? What credible substitutions, cooperative arrangements, and protective obligations alter that dependence? Who can learn that an intervention has changed available practices, question the justification, demand repair, or contribute to revising the rule? How do continuing maintenance, information access, and the distribution of transition burdens affect these opportunities? The formalism can sharpen those questions without prescribing a universal institutional arrangement. The following section develops contestability and institutional reconfiguration as political-economic responses whose effectiveness has to be tested against material constraints, plural valuation, and unequal capacity to shape the conditions of collective life.

12 Contestability and Institutional Reconfiguration

Contestability concerns the practical capacity to question consequential decisions, obtain an intelligible response, and seek alteration or repair of the conditions under which activities remain possible. Within a heterogeneous generative-relational political economy, its significance extends beyond the formal right to express disagreement. The ability to challenge an access rule, oppose the withdrawal of an essential service, protect an ecological relationship, or revise a system of representation depends upon information, material support, competent institutions, and relationships of power. This section examines contestability as an institutionally mediated capability, differentiates it from refusal and exit, and develops a preliminary account of remedy and reconfiguration. The analysis then compares ownership, participation, oversight, and cooperative alternatives across human–AI and multispecies settings. Its method combines conceptual distinctions with established institutional and political-theoretical contributions; proposed criteria remain open to historical and empirical evaluation. The inquiry concerns the political economy of maintaining and revising arrangements, leaving the broader evolution of shared norms among heterogeneous subjects to a separate investigation.

12.1 The Material Conditions of Institutional Contestability

A rule may announce an opportunity to appeal while leaving affected participants unable to identify the operative decision, obtain the relevant evidence, afford a hearing, or sustain their activities while a challenge proceeds. The difference between a declared entitlement and an exercisable practice is central to political-economic assessment. A platform user, for example, may have a procedure for contesting account suspension while lacking access to records needed to explain the suspension; a contracted worker may have a complaint channel but rely on the disputed organization for continuing income; and a community may have formal standing in a resource decision while the technical reports and administrative timetable effectively limit its participation. These examples describe possible mechanisms rather than empirical generalizations about particular institutions. They direct attention to the resources required to use a procedural entitlement.

The feasible-practice account of Section 11 helps specify the distinction. For a participant i , a nominal appeal belongs to the repertoire of legally announced actions, but an effective challenge should appear in the institutionally credible feasible set $\mathcal{F}_i(c)$ only when the necessary supporting practices can be jointly attained. Relevant supporting conditions may include accessible explanation, time, translation, confidential advice, freedom from retaliation, reliable communications, independent adjudication, and continued access to minimum conditions of livelihood or operation. The inquiry therefore asks whether a specific challenge pathway can be completed under an identified configuration and whose interventions can interrupt it. Such analysis remains conditional on the researcher's definition of practical feasibility; it does not imply that a set-theoretic descriptor resolves the normative question of which claims deserve a remedy.

Political theory offers several different reasons to value such pathways. Hirschman's distinction between exit and voice concerns alternative responses to organizational deterioration and their interaction with loyalty [22]. Pettit's republican conception of freedom as non-domination directs attention to capacities for arbitrary interference even when interference remains unexercised [37]. Young's account of inclusive democracy emphasizes how formally available participation can be undermined by social inequalities and prevailing conventions of legitimate political expression [51]. These arguments support distinct diagnoses: inability to influence organizational correction, exposure to discretionary domination, and exclusion within nominally inclusive deliberation. The present discussion treats each as a resource for specifying an institutional mechanism, while preserving differences in their normative premises and intended domains.

For comparative purposes, a challenge pathway can be described through several operational stages: the affected relation becomes identifiable; information concerning the intervention is made accessible; an authorized party can lodge or communicate an objection; the objection receives a hearing by a body with relevant independence or accountability; a decision and reasons are supplied; and an effective corrective option exists where the challenge succeeds. Institutions can satisfy these stages through courts, independent review, community deliberation, worker representation, technical audit, administrative appeal, or combinations suited to the domain. Availability at one stage does not establish availability at the others. In particular, a public complaints portal may increase the number of recorded submissions while leaving remedial authority concentrated in the organization being challenged.

The distribution of costs can determine who actually reaches a hearing. Documentation requirements, waiting periods, legal representation, loss of income, expert consultation, and language barriers may be concentrated on those already dependent on the contested arrangement. An apparently neutral deadline may also have unequal effects when affected groups possess different access to data or different temporal horizons of harm. Comparison should consequently include the availability of interim safeguards, procedural assistance, proportionate evidentiary demands, accessible communication, and the resources needed to preserve a viable position during review. These conditions make contestability a problem of the production and allocation of institutional capacity as well as procedural design.

12.2 Refusal, Exit, and the Credibility of Alternatives

Refusal, exit, and contestation express different practical relationships to an arrangement. Refusal concerns declining a specified demand or intervention while some broader relation may persist. Exit concerns withdrawal from an institutional or productive relation and possible movement to another configuration. Contestation seeks reconsideration of a decision or of the rules that govern the relation. An affected participant may have several such opportunities, one, or none, depending on the material and institutional setting. Hirschman's account illuminates the interaction between exit and voice, including circumstances in which exit weakens incentives or capabilities for internal reform [22]. The present framework adds a concern with unequal control over the conditions making either response credible.

A nominal exit option can be practically inaccessible when withdrawal also eliminates indispensable data, social connections, earnings, equipment access, identity credentials, or ecological conditions of reproduction. The relevant economic question extends beyond the existence of a competitor. It includes the transferability of work and information, the availability of compatible infrastructure, training and adaptation costs, continuity of essential services, and the treatment of collective assets. A user who can open a second account but loses a substantial body of work may face a meaningful constraint; a research group able to change an application provider but lacking independent storage or computing capacity may remain dependent on a shared infrastructure; and a fishing community may have little meaningful opportunity to exit the ecosystem on which livelihood and social relations depend.

The withdrawal-sensitive dependence set $\mathcal{W}_{i|j}(c; w_j)$ introduced in Section 11 can identify practices at risk under a specified withdrawal by j . It can also orient investigation toward substitutes and transition arrangements, provided that researchers examine the credibility, cost, and temporal requirements of each substitute. A portable data archive may reduce a specific technical dependency while maintaining reliance on an identity provider or a proprietary representation format. A cooperative procurement arrangement may reduce unilateral pricing discretion while requiring considerable ongoing administrative labor. Institutional autonomy therefore has several partially independent dimensions, and gains in one dimension may be accompanied by new dependence in another.

Some relations also carry non-substitutable or incompletely substitutable significance. A community's ancestral relation to a river, a species' dependence on a particular habitat, or a person's relationship with a care network may involve historical, cultural, biological, or interpersonal characteristics that would be distorted by counting alternative providers. The Whanganui River settlement framework, including the legal status of Te Awa Tupua and designated institutional roles, is an example of a legally specific arrangement acknowledging a relational understanding of a river and its communities [49]. Its particular foundations should be examined on their own terms. For G2, it illustrates why institutional comparison needs an account of the object and conditions of continuation before applying categories of switching and substitution.

A credible right to refuse may require safeguards against retaliation, collective capacity to negotiate, independent support, or the separation of essential provision from discretionary demands. Exit can similarly depend on interoperation, public alternatives, community institutions, or durable access rights. These measures should be evaluated for their actual effects on the participants concerned. The ability to decline one intervention does not guarantee the capacity to leave an entire relation; retaining a choice among institutions does not automatically confer influence over their common rules. Contestation remains important even when alternatives appear plentiful, especially where multiple providers depend on the same data, legal, ecological, or physical infrastructure.

12.3 Information, Standing, and Authority to Review Decisions

The institutional distribution of information determines which disagreements can become intelligible claims. Affected parties may observe a change in service, livelihood, habitat condition, or working arrangement without access to records of the causal decision. Administrative categories can also shape whose experience becomes reportable: a model evaluation may record task accuracy while excluding the costs borne by data workers; an environmental programme may measure biomass while omitting cul-

turally significant relations; and a platform may register complaints without disclosing the classification rule that produced them. Contestability requires attention to how records are produced, retained, interpreted, and communicated, as well as to the interests of parties able to define the evidentiary standard.

Transparency can support review while exposing other legitimate interests. Disclosing personal records, security-sensitive infrastructure, trade secrets, or vulnerable ecological locations may create further risks. A defensible design can therefore distinguish public explanation, qualified independent access, confidential review, protected testimony, and public reporting of aggregate patterns. The allocation of evidentiary access should be connected to the reviewer's mandate and to the reasons for limiting disclosure. The same distinction applies to automated systems: technical documentation can aid an audit, but a complete technical description would still leave questions about the legitimacy of a policy objective, responsibility for deployment, and the availability of remedy. NIST's voluntary AI Risk Management Framework provides a contemporary example of organizational risk-management processes, while its stated voluntary and use-case-general scope leaves room for separate legal and political judgments about redress [48].

Standing introduces a further asymmetry. Those whose conditions are affected may lack the recognized status to initiate proceedings. In human institutions, representative and collective claims may address this problem, although they can also introduce disputes about authorization and accountability. Young's discussion of structural inequality and group representation provides a reason to assess whether prevailing modes of expression and membership systematically exclude affected perspectives [51]. In multispecies settings, claims on behalf of ecological communities or animals typically pass through people, institutions, scientific practices, and sometimes legally constituted guardians. Their authority, evidentiary competence, competing obligations, and vulnerability to capture deserve explicit scrutiny. A claim to represent an affected nonhuman relation is therefore an institutional and interpretive practice whose adequacy requires evaluation, rather than a direct transmission of an unmediated preference.

Where research concerns current AI systems, the standing of human users, workers, developers, affected communities, operators, and public bodies can be investigated without assuming that the AI system independently holds a legal or moral right to contest. Different questions would arise if future evidence and normative argument justified additional forms of standing for particular artificial systems. That possibility remains open as a research question. In either setting, an operator's opportunity to challenge a rule and the independent moral status of a technical system are analytically distinct.

The reviewer's institutional position matters as much as the form of the hearing. A body financially dependent on the actor being reviewed, deprived of enforceable access to evidence, or unable to order practical changes may provide an appearance of procedure with limited corrective capacity. Independence, expertise, democratic accountability, responsiveness to affected parties, and timely decision-making can pull in different directions; no single design guarantees their simultaneous realization. The appropriate comparison examines the allocation of powers, safeguards against conflicts, review outcomes, and continuing opportunities to revise the oversight arrangement itself.

12.4 Remedy, Restoration, and the Distribution of Transition Burdens

Successful contestation may require several kinds of response. *Correction* changes a particular decision or removes an erroneous restriction. *Restitution or restoration* seeks to recover an affected condition, resource, record, or relation where recovery is possible. *Compensation* addresses a specified loss through a legally or institutionally justified substitute. *Institutional reform* changes rules, responsibilities, or technical arrangements that contributed to the harm. *Assurance* concerns safeguards intended to reduce recurrence, including independent verification or continuing public accountability. These categories overlap in practice, and their suitability depends on the setting and the claims at issue. A reversed account suspension might restore a service yet leave interrupted wages uncompensated; habitat repair may require many seasons and uncertain ecological monitoring; acknowledgement of procedural exclusion may need new arrangements for future participation.

The temporal structure of remedies is central to political economy. Different participants can expe-

rience an intervention across different intervals: interruption of immediate income, loss of accumulated skills, a changed research trajectory, disruption of ecosystem reproduction, or ongoing distrust of a governing institution. A short review deadline may formally resolve a dispute while the affected conditions remain damaged. The continuity construction $C_i^H(c)$ in Section 11 offers a way to ask which specified modes of functioning can remain attainable over a chosen horizon. It does not determine which continuity objectives deserve priority, and the empirical choice of H requires independent justification. Ecological regeneration, community livelihood, institutional accountability, and technical service continuity may accordingly require parallel forms of evidence and differently paced responses.

Remedies also redistribute costs and authority. Repairs must be planned, financed, performed, maintained, and monitored. Some costs may fall on workers who implement new procedures, communities asked to document historical loss, organizations required to fund alternative infrastructure, or public institutions that provide independent oversight. The political-economic analysis should examine who benefits from the original arrangement, who bears its corrective costs, and who can revise the remediation plan. A nominally participatory remedy can reproduce asymmetry when vulnerable groups must undertake unpaid evidentiary labor to obtain recognition. Conversely, an externally financed remedy may create dependence on the funder's continuing approval. Comparisons therefore need to track both the circulation of remedial resources and the conditions for retaining control over them.

In environmental governance, an apparent restoration may be assessed differently through species indicators, local livelihoods, cultural obligations, hydrological processes, or long-term ecological relationships. The IPBES assessment of diverse values provides an empirical and methodological reason to recognize multiple ways of valuing nature in policy processes [27]. A political-economic study should document the evaluative method, its authority, the people and relations represented, and uncertainties in predicted outcomes. Monetary compensation can be relevant to specified losses; it cannot be presumed to replace every relational or ecological condition. Similarly, the restoration of a technical service may satisfy one institution's continuity criterion while leaving previously excluded users with diminished influence over its rules.

The distinction between remedial adequacy and institutional legitimacy remains important. A decision-maker may voluntarily repair a harmful result while retaining unilateral discretion to withdraw the remedy. A public procedure may provide formal reasons while producing weak material change. Conversely, an urgent protective intervention may be substantively beneficial while its authority and proportionality remain contested. The research object is consequently multidimensional: the occurrence of correction, the durability of restored capabilities, the distribution of responsibilities, and the legitimacy of the procedures through which remedial judgments were reached.

12.5 Collective Governance and Alternative Production Arrangements

Institutional reconfiguration extends beyond improvement of existing complaints procedures. It may change ownership, access rights, standards, resource pooling, maintenance responsibilities, representation, the distribution of technical competence, and the authority to change future rules. A productive arrangement can move from unilateral provision to cooperative management, public infrastructure, community ownership, federated provision, regulated private services, or combinations of these forms. Each design creates particular opportunities and dependencies. The comparison should consider how resources are generated, who maintains them, how disagreements are settled, and whether participants possess realistic means to alter the arrangement when circumstances change.

Ostrom's institutional research demonstrates the diversity of arrangements through which users have organized and governed common-pool resources, alongside cases of fragility and failure [35]. The relevance to heterogeneous systems lies in the importance of situated rules, monitoring, collective-choice arrangements, and institutional adaptation. Direct transfer of any specific commons design to AI computation, ecological stewardship, or transnational infrastructures would require further argument. A shared software repository, for example, differs from a fishery in rivalry, exclusion, reproduction costs, and technical architecture; both may nevertheless raise questions about credible participation, maintenance

work, and the distribution of enforcement authority.

Collective decision-making can reduce unilateral discretion while introducing problems of agenda control, unequal expertise, coordination burdens, and majority domination. A formally participatory institution can privilege participants with time, technical knowledge, language skills, or professional recognition. Representative arrangements can broaden access while giving officeholders new discretion over others' interests. Multi-level governance can localize decisions yet shift critical infrastructure decisions to remote suppliers. A comparative assessment should therefore identify the institutional level at which a consequential choice is actually made and the participants who can change it. Institutional pluralism provides a repertoire of possible arrangements, while their performance and legitimacy remain empirical and normative questions.

In AI-mediated production, relevant alternatives may include usable data export, interoperable interfaces, independently governed repositories, public-interest compute access, shared auditing facilities, worker participation, and contractual procedures that allocate responsibility for model changes or service interruption. These are proposals for investigation, rather than claims that each would improve every system. For example, interoperability can improve switching options while creating security, privacy, compatibility, or financing costs. Public provision can reduce some forms of commercial dependence while making public accountability and procurement governance more consequential. Cooperative ownership can increase member influence while depending on specialized technical maintainers. The appropriate inquiry compares the resulting feasible-practice repertoires and the location of continuing discretionary power.

In ecological or multispecies governance, the conditions of production and reproduction include habitats, water, energy flows, monitoring capacity, and collective practices of care and stewardship. Here the governance problem extends to relations with affected populations that cannot take part in ordinary human deliberation on the same terms. Legal guardianship, community stewardship, independent ecological review, and culturally situated obligations are among possible arrangements. The Te Awa Tupua statute illustrates the specificity of a governance framework in which legal personality, designated representatives, and collaborative structures are separately provided for by law [49]. Its legal particulars do not supply a general template for all ecosystems. They demonstrate the importance of institutional design when representation, stewardship, and rights of intervention are distributed across different bodies.

The choice among reforms is also a choice about the reproduction of reform itself. Participatory review requires trained personnel, independent funding, accessible archives, and authority to enforce decisions. An alternative infrastructure requires replacement parts, energy, governance labor, and continuity arrangements under stress. A protected ecological corridor may require sustained monitoring, coordination across jurisdictions, and the resolution of changing livelihood demands. Reconfiguration succeeds on its own terms only to the extent that the practices sustaining new arrangements remain feasible through the disturbances that matter for the inquiry.

12.6 Comparative Institutional Assessment across Heterogeneous Relations

A single institutional score would conceal several differences that matter for analysis. Table 11 provides a provisional comparative register. It organizes questions around the exercise of challenge and the reproduction of alternatives, while making foreseeable failures explicit. The register is a guide to case design and documentary evidence, rather than a validated index or a set of universal institutional standards.

The register can be applied to a defined institutional change by comparing the configuration preceding the change with a documented alternative. The investigator should specify which participants are within scope, which material and interpretive conditions are relevant, the temporal windows considered, and the quality of available evidence. A change that expands $\mathcal{F}_i(c)$ for some participants may contract the feasible repertoire of others. A new review body may provide protection against one operator while becoming dependent on a small group of experts. A new open infrastructure may broaden access while imposing substantial maintenance burdens. Such trade-offs are research findings to be documented and argued about, rather than folded automatically into a single net-benefit judgment.

Table 11: Provisional register for evaluating contestability and institutional reconfiguration

Institutional dimension	Evidence to examine	Possible failure or rival interpretation
Practical standing and access	Eligible complainants, representation arrangements, assistance, actual completion of proceedings	Formal entitlement conceals cost, intimidation, or exclusion.
Information and explanation	Decision records, documentation access, independent expert review, protected disclosure	Disclosure is selective, unintelligible, or unsafe.
Refusal and alternatives	Portability tests, replacement capacity, livelihood continuity, credible non-retaliation	Alternative exists nominally but requires unaffordable transition.
Independent review and revision	Reviewer powers, conflicts of interest, reasoned decisions, enforceable changes	Hearing processes complaints without capacity to change outcomes.
Remedy and reproduction	Restoration outcomes, time horizons, maintenance finance, distribution of repair labor	Short-term correction shifts burdens or creates renewed dependency.
Plural representation	Stakeholder accounts, ecological measures, guardian mandates, competing interpretations	One authorized voice obscures divergence or vulnerability.
Rule-making and governance	Participation in rule revision, ownership structures, agenda control, access to infrastructure	New procedures relocate rather than diminish concentrated discretion.

Consider three stylized comparisons. In a data-dependent research service, the investigator could compare procedural appeals, actual restoration rates, data export usability, independent compute availability, and the share of governance decisions open to users or workers. In a coastal conservation arrangement, comparison could combine livelihood and maintenance evidence, ecological observations, representation mandates, and the ability to alter monitoring or access rules. In a hypothetical encounter with a much more capable nonhuman civilization, the question would concern whether offered protection preserves meaningful human opportunities for collective judgment, refusal, and correction, subject to the encounter's stipulated constraints. The final case is a consistency test within political philosophy; empirical evidence for such contact is neither claimed nor implied.

A useful comparative study also needs adverse cases. Appeals may be procedurally accessible but systematically unsuccessful; exit may improve the position of mobile participants while weakening those who remain; community governance may disproportionately burden already overworked members; and highly specialized review may improve technical accuracy while weakening public understanding. For each apparent improvement, the investigator should seek evidence of displaced costs, changing authority, and competing causal explanations. Historical reconstruction, interviews, legal analysis, technical testing, ecological observation, and causal inference may each contribute, according to the question and ethical constraints. Their outputs should remain distinguishable where they answer different questions.

12.7 Institutional Revisability and the Boundaries of Political-Economic Repair

The provisional conclusion is that contestability has a productive and reproductive infrastructure of its own. Information has to be preserved, communicative and legal channels maintained, knowledgeable reviewers supported, corrective decisions implemented, and alternative arrangements kept viable. These activities consume resources and distribute power. An institution that recognizes a challenge pathway in its formal rules may thus remain weakly contestable in practice, while one that sustains material capacity for refusal, collective organization, and repair can make discretionary authority more answerable to those affected. The difference is open to case-specific examination through the register proposed in Table 11.

Institutional reform also raises enduring normative disagreements. Affected participants may dispute who should represent an ecological relation, which forms of economic loss merit compensation, how scientific uncertainty should influence precaution, how much discretion is appropriate in an emergency, and which obligations persist after an organization has exited a relationship. Feasible-practice analysis

can identify some consequences of proposed arrangements, while legal, democratic, ecological, and philosophical reasoning is required to assess legitimate authority and acceptable trade-offs. Institutional arrangements may enable ongoing argument without requiring a comprehensive prior convergence of value judgments.

The analysis preserves the distinction among three projects. G2 identifies the productive conditions, asymmetries, value relations, and institutional channels through which challenges and reforms can be carried out. The evolutionary constitution and transformation of norms across heterogeneous systems remain the more specific object of G3. The ontological status and generative organization of order remain the separate object of G1. These interfaces matter because a procedure that increases practical contestability can be evaluated within a political economy while deeper disagreements over subjecthood, values, or social ontology remain unresolved.

Section 11 supplied conditional formal descriptions of dependence; the present section translates those descriptions into empirical questions about refusal, access, representation, remedy, and institutional redesign. The remaining inquiry concerns the strength of the manuscript's explanations. Its proposals are vulnerable to incomplete measurement of feasible alternatives, ambiguous causal attribution, contradictory evaluative standards, and historical variation in what counts as an institution or a participant. A comparative evaluation must expose these difficulties, examine rival accounts, and define conditions under which specific propositions should be revised or rejected. That methodological task provides the subject of the following section.

13 Research Limitations and Comparative Evaluation

The explanatory value of a heterogeneous generative-relational political economy depends on its capacity to distinguish consequential mechanisms from alternative explanations, connect proposed concepts to defensible observations, and specify the conditions under which its interpretations should be revised. The preceding sections identified historically constituted conditions of production and reproduction, uneven control over those conditions, heterogeneous circulation of value, interpretive authority, and the institutional capacity for contestation. Their conjunction supplies a research programme rather than a validated general theory. This section evaluates the programme's limitations by examining competing mechanisms, construct validity, causal identification, historical and cross-domain comparisons, plural valuation, and the politics of evidence. It concludes with a comparative research protocol and explicit criteria for revision. The method is methodological and critical: proposed research designs are assessed according to the claims they could warrant, while philosophical and normative disagreements retain their distinct evaluative requirements.

13.1 Rival Mechanisms and the Discrimination of Explanations

Several observations emphasized in this manuscript admit more than one plausible explanation. A research group's dependence on a computing provider might reflect concentrated discretionary power, substantial fixed costs and economies of scale, regulatory requirements, technical complementarity, or the researchers' preference for a reliable service. A worker's limited success in disputing a platform decision might result from unequal access to evidence, deficiencies in review design, genuinely weak grounds for appeal, or differences in the cases brought forward. Ecological degradation within a regulated area might involve extractive incentives, imperfect monitoring, climatic variability, historical disturbance, or conflicting interpretations of the applicable conservation goals. Treating each observed asymmetry as evidence for one favored mechanism would weaken the explanatory ambition of the analysis.

The working hypothesis of G2 concerns the political-economic effects of control over conditions that sustain feasible practices. More precise hypotheses must therefore identify *which control*, over *which condition*, by *which participant or institution*, within *which time horizon*, and with *what observable consequences*. In a data-service setting, a hypothesis about discretionary lock-in can be compared with a hypothesis about unavoidable conversion costs. Both may predict low rates of switching. The first

3043 additionally predicts changes in switching opportunities when interface permissions, portability rules,
3044 or unilateral contractual discretion change while relevant technical constraints are comparatively stable.
3045 The second predicts persistence of substantial costs where independent substitutes preserve interoper-
3046 ability and access but engineering transformation remains expensive. These predictions are conditional;
3047 changes to contractual discretion may simultaneously affect service quality, investment, and the selection
3048 of users.

3049 Power relations also operate through different pathways. A resource holder may control supply, de-
3050 fine eligibility, restrict access to records, influence classification, set remedial procedures, or shape what
3051 alternatives can be built. These interventions can reinforce one another while carrying different empir-
3052 ical signatures. A concentration of computing capacity alone is an incomplete proxy for any particular
3053 intervention repertoire. Comparisons require a reconstruction of ownership, contractual rights, technical
3054 permissions, institutional review mechanisms, and the practical ability of others to substitute, refuse, or
3055 reorganize their activities. Work on platform production, structural power, and the organization of invis-
3056 ible labor supplies useful distinct starting points for these reconstructions [43, 46, 20]; the proposed G2
3057 mechanisms remain additional hypotheses subject to case-specific testing.

3058 A demanding assessment should actively examine observations that complicate the preferred account.
3059 Strong concentration may coexist with meaningful portability or effective independent review. Decen-
3060 tralized ownership may coexist with severe dependency on a shared technical standard, access to scarce
3061 expertise, or an unaccountable local authority. A legal reform may increase recognized standing while
3062 reducing the resources available to maintain a service. Evidence of such combinations can help disaggre-
3063 gate productive efficiency, bargaining asymmetry, discretionary interference, normative legitimacy, and
3064 institutional performance. It may also reveal that the relevant unit of control is a coalition, governance ar-
3065 rangement, or infrastructure rather than an individual actor. Explanatory revision in these circumstances
3066 is a substantive advance, since it specifies the mechanism more closely.

3067 13.2 Construct Formation and the Validity of Observations

3068 The constructs used in this paper vary in their relationship to directly observable records. Electricity
3069 consumption, employment contracts, documented rule changes, and the presence of an appeal proce-
3070 dure may be measured with comparatively explicit units or documentary criteria. Generative capacity,
3071 practical autonomy, social reproduction, institutional legitimacy, and a participant’s feasible repertoire
3072 require additional interpretive decisions. Measurement validity concerns the defensibility of the rela-
3073 tion between a specified concept and the observations selected to represent it. Adcock and Collier’s
3074 account distinguishes conceptual clarification from the validity of operational indicators and emphasizes
3075 the dependence of measurement claims on context [1]. That distinction is especially pertinent where
3076 superficially comparable records arise from markedly different productive systems.

3077 The terminology of heterogeneous *subjects* also needs deliberate restraint. Human persons, legal
3078 organizations, software services, artificial agents, animal populations, and ecosystems enter political-
3079 economic records under different descriptions. A platform account might denote one person, a team,
3080 an automated process, or an institutional customer. The observable agency of an automated service
3081 does not itself settle questions of consciousness or moral standing. A watershed may be represented
3082 through legal guardians, ecological indicators, customary relations, and administrative jurisdictions, each
3083 of which captures a different aspect of the relation under study. A credible dataset should identify whether
3084 an observation concerns a human person, organizational decision unit, technical process, population,
3085 ecological condition, or legally recognized entity, as well as the rules used to connect records across
3086 those levels. Ontological disagreement need not prevent analysis of a specified relation, provided that
3087 the adopted unit and the limits of its interpretation remain explicit.

3088 The formal constructs introduced in Section 11 are particularly vulnerable to incomplete observation.
3089 The set $\mathcal{F}_i(c)$ describes practices feasible under a stipulated configuration and supporting conditions; a
3090 dataset of observed actions records what occurred, potentially among a much larger set of feasible prac-
3091 tices. Actual behavior can be shaped by preferences, beliefs, lack of information, risk, coercion, or con-

vention. Conversely, an apparently available alternative may depend on hidden credentials, unavailable energy, unaffordable transition costs, or approvals that cannot be reliably obtained. A defensible analysis should distinguish documented opportunity, technically feasible opportunity, institutionally credible opportunity, and actually realized activity. The category adopted for a given study should be justified by the research question and tested for sensitivity to its assumptions.

The problem also applies to claims about voice and contestability. Counts of grievances or appeals can increase because channels have become more accessible, because contested decisions have become more frequent, because individuals have become more willing to complain, or because organizations have changed how cases are recorded. A high proportion of successful appeals may reflect effective review, restrictive intake procedures, prior informal settlements, or the selection of unusually strong claims. The staged account in Section 12 suggests collecting information on eligibility, access to records, attempted challenges, completion, time to response, reasons, enforceable decisions, and downstream repair. Interviews and procedural observation may reveal barriers invisible in administrative aggregates, while documentary and technical checks may identify discrepancies in self-reported access. Each source answers a narrower question than an omnibus measure of institutional fairness.

Measurement conventions can also change the phenomenon observed. Institutional metrics may become targets for organizational adaptation; an actor evaluated by the share of appeals resolved may accelerate closure, redefine what counts as a resolution, or shift disputes to other channels. Studies of quantification and classification emphasize the social consequences of apparently neutral recording categories [31, 6]. The comparison should therefore record the historical establishment of categories, the custodians of the measurement process, revisions to administrative definitions, and foreseeable strategic responses. Where validation fails, an indicator should be withdrawn, replaced, or described only at the narrower level it demonstrably measures.

13.3 Causal Identification in Interdependent Infrastructures

Political-economic interventions frequently affect several linked participants and conditions at once. A change in model-provider access terms can alter training and deployment costs, researchers' organizational choices, employment arrangements, and the demand for substitute infrastructures. A conservation rule may affect ecological processes, livelihoods, enforcement resources, and neighboring jurisdictions. Observed changes following an intervention accordingly cannot automatically be assigned to the intervention itself. An empirical design should specify a particular intervention, the relevant comparison, the outcome, and the period over which the outcome is assessed. The identification conditions of consistency, exchangeability, and positivity articulated in modern causal-inference methodology help clarify why observational comparisons may fall short of causal claims [21].

In a narrowly defined human–AI case, the estimand might concern the effect of an enforceable data-export requirement on the proportion of participating organizations that can complete a verified migration while maintaining a specified minimum level of operational continuity. The intervention needs a sufficiently precise definition: an announcement, a legal entitlement, a functioning export interface, an interoperability standard, and an independently tested migration process are different institutional changes. Relevant outcomes include successful completion, downtime, retention of usable records, technical conversion expenditure, changes in provider choice, and burdens borne by workers or users. Selecting only organizations that attempted migration after reform would risk conditioning on a decision influenced by the reform. Comparing adopters with non-adopters without addressing their different capabilities and anticipated benefits would similarly confound the inference.

Where conditions permit, staggered reforms, administrative thresholds, exogenous disruptions, documented phased rollouts, or carefully bounded within-unit comparisons may create useful variation. Their suitability depends on the institutional assignment process and the stability of relevant assumptions. Parallel-trend claims in difference-in-differences designs, for example, require substantive scrutiny when providers and users change behavior in anticipation of a new rule. The same supplier may serve treated and comparison units, creating spillovers through shared infrastructure or pricing. Stronger organizations

may obtain exemptions or priority support, undermining comparisons that implicitly assume comparable assignment. For longitudinal designs, the composition of the participant population may also change because vulnerable organizations disappear from the records. Estimation methods should be selected after these design questions have been examined, and unobserved confounding or selective attrition should be reported as limitations where they remain unresolved.

Interdependence creates a particularly important distinction between a *unit-level* intervention and a *configuration-level* intervention. The practice projections $\mathcal{F}_i(c)$ and $\mathcal{C}_i^H(c)$ depend on joint constraints. Changing the arrangements of one participant may alter the conditions under which other participants act, so outcomes cannot necessarily be treated as independent responses to a common intervention. Research on supply-chain rules, interoperable standards, ecological corridors, or cooperative infrastructures may therefore need a network or jurisdiction as its analytical unit. At the same time, aggregate comparison can conceal distributive effects within the affected network. The unit used for causal attribution and the units used for assessing differential consequences should be declared separately.

Historical reconstruction and process evidence can also discriminate mechanisms when statistical identification is limited. Contracts, archives of technical changes, minutes of rule-making meetings, maintenance logs, incident records, and interviews may establish the sequence through which a decision altered access or concentrated control. Such material may support a well-corroborated causal narrative within a case while leaving the size of a counterfactual effect unresolved. A comparative study should distinguish mechanistic plausibility, documented sequence, estimated causal effect, and justified generalization. These are different achievements; the presence of one does not supply the others.

13.4 Historical Variation and Comparative Case Selection

The political-economic objects discussed in G2 have historically variable boundaries. The legal meaning of an autonomous organization, the ownership of training data, the technical conditions of computing provision, and the social recognition of care labor can change across time and jurisdiction. Ecological governance spans biological, legal, and political timescales whose observation windows may diverge substantially. A historical comparison that labels two institutions with the same category may therefore combine materially different arrangements. The research design should reconstruct the conditions in which the comparison becomes meaningful, including the provenance and revision of its main categories.

Case selection also shapes which mechanisms are likely to appear. Choosing only dominant AI providers, exemplary participatory conservation arrangements, or especially visible institutional failures may exaggerate particular forms of control or contestability. The typology of case-selection strategies developed by Seawright and Gerring offers alternatives suited to different inferential aims, including typical, diverse, extreme, and deviant cases [41]. For the present programme, a useful comparison might begin with two research infrastructures that provide a similar type of service but differ in governance and portability rules. Additional cases with contrasting technical dependence, funding arrangements, or user composition could test how far the initial mechanism travels. Deviant cases, such as highly centralized providers with effective contestation or nominally participatory bodies with limited practical voice, deserve particular attention.

Historical materialist approaches direct attention to relations of production and reproduction, while institutional analysis supplies techniques for describing rules, positions, actions, and outcomes [16, 36]. These traditions illuminate overlapping but distinct research questions. A longitudinal study of an AI service might trace financing, work organization, energy contracts, deployment institutions, user practices, and control over model adaptation. A multispecies study might reconstruct land or water tenure, customary knowledge, biological reproduction, extraction pressures, and the changing public institutions that authorize interventions. In either domain, the categories used by affected communities may diverge from those used by analysts or officials. Analytic comparability is strengthened through explicit translation rules and acknowledgement of what those rules leave out.

Generalization is appropriately conditional. A finding that independent data-portability enforcement reduced one form of discretionary interference in a particular service sector would not by itself establish

a general result for ecological stewardship, human employment, or hypothetical relations with extraterrestrial subjects. Comparative inference should identify the conditions under which the relevant mechanism may persist: the substitutability of resources, legal standing, concentration of decision authority, communicative access, time horizons, and the reproducibility of alternative arrangements. Where these conditions differ, the comparison can still clarify conceptual boundaries, even where a shared causal estimate would be misleading.

13.5 Cross-Domain Comparison and Plural Valuation

The proposed framework encounters an additional limitation when participants' goods and harms resist commensuration. A service operator may describe increased throughput, a worker may report intensified demands, a community may emphasize autonomy or enduring relationships, and an ecological assessment may identify a decline in habitat suitability. These claims can be jointly relevant without sharing a common valuation unit. Scholarship on commensuration shows that converting diverse qualities into shared quantitative categories is itself a consequential social process [14]. The IPBES assessment of the diverse values of nature similarly offers reasons to attend to plural practices of valuation and their implications for decisions [27].

For cross-domain evaluation, the researcher should specify a bounded set of dimensions and the evidence appropriate to each. One dimension may concern continued access to indispensable material conditions; another may concern the range of permissible practices; others may record authority to alter rules, institutional opportunities for challenge, burdens of maintenance, ecological continuity, or distributions of benefits and risks. A comparison can identify improvement or deterioration along a specified dimension while leaving other dimensions contested. Even when ordinal comparison is plausible within one domain, it may lack a defensible translation into another. An ecological indicator, a legal right of appeal, and a worker's experienced insecurity serve different analytical purposes.

Normative appraisal requires an additional account of whose reasons count and how incompatible claims are addressed. The distinction between feasible practices and rightful practices remains essential here. Expanding an industrial operator's repertoire may diminish habitat integrity; restricting a harmful practice may preserve biological reproduction while imposing a heavy livelihood burden on a vulnerable group. The descriptive result can be comparatively clear while judgments about permissible restrictions, compensation, collective responsibility, and representation remain disputed. Young's account of structural inequality and inclusion and Meijer's work on multispecies injustice provide resources for considering affected relations beyond a narrow inventory of individually expressed preferences [51, 30]. Their respective ethical arguments should retain their own provenance and be assessed in the domains to which they speak.

One possible reporting method is a *partial comparative profile*: the study presents domain-specific findings, records the decision rules employed, identifies dimensions for which comparison is justified, and marks conflicts that remain open. This is a proposal for evidence organization, neither a welfare theorem nor a universal social-choice procedure. The adoption of weights, thresholds, vetoes, or compensation rules constitutes a further political and normative choice requiring justification and, where appropriate, procedures through which affected participants or their legitimate representatives can contest that choice. Keeping these stages distinct helps preserve substantive disagreements as visible findings rather than treating them as measurement noise.

13.6 Evidence Access, Representational Asymmetry, and Researcher Position

The political economy of knowledge production affects the evidence available to study political economy itself. Platform operators may possess detailed logs unavailable to users and independent researchers; public agencies may hold records in formats costly to reconcile; workers or communities may have situated knowledge that administrative classifications exclude. Institutions can also control the timing of disclosure, the definition of reportable events, and the confidentiality rules governing independent review. These conditions influence which mechanisms become empirically legible. The sociology of

infrastructure and classification provides reasons to study such documentation practices as part of the relation, rather than treating records as neutral windows onto it [45, 6].

An evidence audit should therefore identify custodianship, provenance, gaps, access conditions, incentives for strategic reporting, and material barriers to obtaining alternative accounts. In a technical system, independent testing can establish whether a documented export or refusal option functions for a specified user profile. In a labor relation, interviews can reveal informal sanctions or unrecorded support work, subject to appropriate confidentiality and sampling constraints. In an ecological case, scientific observations may be combined with local histories and jurisdictional records while preserving differences in epistemic practice. Triangulation can reveal discrepancies as well as convergence. Disagreement among records may reflect measurement error, different units of observation, or a substantive conflict about what counts as the phenomenon.

The researcher also occupies a position within the relations under study. Access can depend on institutional sponsorship, funding, technical privileges, or obligations of confidentiality. A study that relies exclusively on one operator's records may reproduce its categories of success and failure. Conversely, researcher advocacy for a particular institutional arrangement can affect interview access, participant trust, and the interpretation of ambiguous events. A defensible inquiry should disclose relevant dependencies and analytic decisions, protect participants who face retaliation or exposure, and distinguish empirical evidence from normative argument. These requirements are especially significant where vulnerable communities, workers, or living systems are represented indirectly.

Artificial systems introduce additional documentary difficulties. A model's response, internal measurement, or apparent preference can be useful evidence concerning its observable performance under a defined test. Such outputs do not settle its welfare interests, moral status, or relation to conscious experience. The same caution applies to the use of aggregate ecological indicators as substitutes for all the interests and relations associated with a living system. G2 can examine who produces, owns, interprets, and acts upon these representations while leaving questions of ultimate subjecthood and ontology open. This separation supports empirical inquiry without resolving philosophical questions by administrative classification.

13.7 A Comparative Protocol for Testing Political-Economic Claims

The preceding limitations suggest a staged research protocol. Table 12 connects central G2 claims to discriminating observations, rival explanations, and interpretation boundaries. It provides an agenda for designing studies, not a completed evidence synthesis. The table should be read alongside the practical institutional register in Table 11 and the formal operational register in Table 10: the latter describe what might be examined, while the present register specifies how the resulting inferences could fail.

In practical use, a study would begin by stating the bounded political-economic relation, the units of observation, and the historically situated question. It would then define an intervention or contrast, specify the hypothesized mechanism and rival accounts, and declare what evidence would distinguish them. Measurement procedures should document the distance between the source records and the concept. Causal interpretation should address selection, anticipation, interference, missingness, and the plausibility of a relevant counterfactual. The analysis should separately record descriptive results, supported mechanism claims, causal estimates where identified, and normative assessments based on stated standards. For outcomes with heterogeneous or contested values, reporting should preserve distinct profiles and explain any aggregation rule.

A comparative study of AI research infrastructure could, for example, pair organizations subject to different enforceable portability regimes while measuring their baseline technical requirements, dependence on external credentials, migration failures, governance participation, and maintenance burdens. A second investigation might examine the same relation longitudinally across an independently documented rule change. A multispecies comparison could examine differently governed watersheds using ecological observations, livelihood records, and jurisdiction-specific representation arrangements, with historical shocks and assessment methods reconstructed explicitly. Cross-domain synthesis would then

Table 12: Comparative research protocol for provisional G2 mechanisms

Proposed mechanism	Discriminating observations or design	Rival account and inference boundary
Infrastructure-mediated dependence	Verified withdrawal or portability scenarios; provider rights, conversion requirements, continuity tests	Technical complementarity or preferred service quality; access records alone cannot identify coercion.
Discretion over feasible practices	Documented changes to permissions, contracts, or eligibility with comparable affected units	Scarcity, legal duties, and concurrent innovations; behavioral change alone underidentifies the channel.
Interpretive or classificatory power	Versioned standards, classification appeals, divergent audits, case files	Legitimate specialization and measurement error; classification disparity alone does not establish abuse.
Heterogeneous value circulation	Separate benefit, cost, maintenance, and return records across participating positions	Differing valuation conventions; multidimensional accounts resist a universal sum.
Effective contestability	Eligible populations, case attrition, evidence access, binding revision, post-remedy continuity	Selection of stronger appeals and strategic reporting; complaint volumes are ambiguous.
Ecological and multispecies governance	Longitudinal ecological measures, livelihood evidence, representation mandates, local accounts	Environmental shocks, historical disturbance, and disputed representation; translation remains partial.
Institutional reconfiguration	Phased reform, well-matched contrasting cases, displaced burdens, sustained operation	Selection into reform and spillovers; short follow-up misses reproductive costs.

focus on whether comparable *mechanisms of discretionary control, dependence, and remedy* were identified under stated conditions. It would avoid treating superficially similar numerical indicators as interchangeable evidence of value, justice, or generative capacity.

The extraterrestrial reversal remains a separate logical exercise. A hypothetical power reversal can probe whether institutional judgments change solely because humans occupy the weaker position, while a coherent counterfactual should stipulate the capacities, material requirements, and communication limits on which that judgment depends. Such exercises can expose contradictions in principles and omissions in a normative vocabulary. They provide no empirical estimate of extraterrestrial conduct and cannot establish that the assumptions of the hypothetical obtain in the world.

13.8 Revision Criteria and the Scope of the Research Programme

The strongest research outcome is one that establishes where an account succeeds and where it must change. Several results would call for more than minor terminological adjustment. If purportedly credible alternatives repeatedly prove unusable, the employed feasibility indicators require revision. If the association between concentrated infrastructure and constrained practices disappears after accounting for technical constraints and institutional protections, a broad concentration-based explanation should give way to a more specific account of the conditions under which concentration is consequential. If expanded appeal procedures leave actual redress unchanged, the relevant institutional mechanism should be disaggregated across access, decision authority, enforcement, and subsequent continuity. If affected groups use persistent and defensible value descriptions that the comparative framework cannot represent, its valuation dimensions should be enlarged or its intended domain narrowed.

Other limitations concern missing evidence. Proprietary records, sparse ecological baselines, the unobservable practices that participants might have pursued, and changes in legal meaning over time may prevent persuasive identification even where the hypothesized mechanism remains plausible. The appropriate result in such cases is a bounded descriptive or interpretive finding, coupled with a specification of what additional evidence would be required. Researchers should also report genuine counterexamples, inconclusive comparisons, measurement choices that alter findings, and costs shifted outside the chosen unit of analysis. A mature research programme may contain heterogeneous empirical results while preserving a common discipline of explicit claims, tests, and revision.

The present framework's limits are also philosophical. Formal dependence does not establish welfare or legitimacy. Behavioral resemblance alone leaves open the constitution and moral standing of artificial systems. The history of a river, the interpretation of an ecological community, and the functioning of an automated infrastructure may require methods and concepts that exceed the reach of political-economic analysis. The model's configuration and time-horizon choices remain methodological conveniences under ontological suspension. Detailed evolutionary accounts of intersystem norm formation belong primarily to G3, while the constitution and status of generative order form the more specific concern of G1. These boundaries protect the present inquiry from claiming authority over questions for which it has supplied only an interface.

The proposed next stage is therefore a sequence of bounded investigations: conceptual validation of key political-economic constructs; documentary and qualitative reconstruction of selected relations; comparative testing of specified interventions and rival mechanisms; and explicit public examination of the normative premises adopted in evaluating different outcomes. These activities can proceed in partly overlapping orders, provided that each inquiry declares what its available evidence warrants. The conclusion of the manuscript will draw together the resulting theoretical commitments as provisional propositions and identify the continuing questions on which their usefulness depends.

14 Conclusion

This preliminary inquiry has examined the political-economic constitution of heterogeneous generative-relational participants through their histories of production, conditions of reproduction, practical capabilities, relations of dependence, and opportunities to shape the institutions governing their interaction. Its central contribution is a comparative orientation that treats material feasibility, the circulation of heterogeneous value, interpretive authority, and institutional contestability as connected yet analytically distinguishable objects. The concluding discussion consolidates the proposed contributions, specifies conditional propositions emerging from the analysis, considers their implications for institutional evaluation, and identifies the research needed to determine where the framework is useful. The synthesis is conceptual and methodological. Its provisional formal constructions have yet to be calibrated or validated against a systematic comparative body of evidence, and the normative conclusions depend on arguments that must remain open to public and disciplinary scrutiny.

14.1 The Analytical Contribution of Heterogeneous Political Economy

The first contribution concerns the relation between observable performance and political-economic constitution. Similar responses or productive outputs can arise through substantially different histories of learning, embodiment, organizational support, material supply, and institutional authorization. A human researcher, a deployed AI service, and an organizational decision system may contribute to one task while occupying different positions in the production of its requirements and the governance of its results. Descriptions centered exclusively on output equivalence may therefore obscure the conditions under which a capability can be sustained, transformed, interrupted, or appropriated. The analysis proposed in Sections 2 and 3 supplies questions for reconstructing these differences without claiming that every observed divergence has political-economic significance. The relevant explanation must identify an effective mechanism connecting the participants' relational histories to their opportunities and vulnerabilities.

The second contribution places the reproduction of productive conditions alongside the distribution of productive results. Labor, livelihood, infrastructure, energy, ecological regeneration, shared information, maintenance, and institutional continuity can each condition which activities remain possible. Their significance is relational and temporally extended: an arrangement may increase immediate productive output while transferring costs of maintenance, adaptation, or failure to other participants or observation horizons. The analysis in Section 4 therefore suggests examining the organization of continuing capabilities as an object of political economy in its own right. Reproductive analysis is especially important

when benefits can be registered immediately and the requirements for sustaining them remain dispersed across workers, communities, ecological systems, and technical operators. A responsible account should specify the selected horizon and the evidential status of its claims about continuity.

The third contribution connects these material conditions to power without treating dependence as a sufficient verdict on the relationship. Cooperative specialization, legitimate coordination, technical scarcity, and concentrated discretion can all organize asymmetric access to productive resources. The political-economic task is to identify who can select among consequential changes to another participant's feasible practices, the constraints on that selection, and the credible alternatives available to those affected. Sections 5 and 11 develop this distinction in conceptual and set-based terms. It permits investigation of concentrated influence while retaining the possibility that a particular intervention is justified, beneficial, compelled by a public obligation, or effectively constrained by independent review. Power analysis consequently gains precision when discretionary capacity, observed exercise, outcome, recognized authority, and normative justification are reported separately.

14.2 Provisional Propositions on Dependence and Institutional Power

Several propositions can be extracted from the manuscript as conditional research commitments. They constitute a programme of inquiry and remain open to counterexamples, alternative explanations, and changes in the concepts used to describe heterogeneous participants. Their value depends on the clarity of the conditions under which they are asserted and on the evidence by which they might be discriminated from established theories.

A first proposition concerns *historically differentiated capability*. Where apparently equivalent activities depend on different material and institutional histories, the continuity and distributional consequences of those activities may diverge under the same change in governance or resources. The proposition directs attention to training and labor histories, infrastructural interfaces, access rights, forms of maintenance, and relations of care. Its empirical usefulness would be limited if output-based or conventional institutional variables already explained the relevant variation adequately. It also requires a defensible specification of what counts as equivalent output and a locally warranted account of relevant history.

A second proposition concerns *reproductive dependence and effective discretion*. When participant j can selectively change conditions under which i maintains certain practices, and when those practices lack credible substitutes over the relevant horizon, a potentially consequential power asymmetry arises. The conditional formulation matters. Scarcity or operational interdependence alone may constrain both participants without granting either discretionary control. Conversely, formal rights to exit may coexist with prohibitive switching costs, unavailable replacement resources, or dependence on the same institution for dispute resolution. The feasible-practice and intervention constructions in Section 11 provide a way to state the contrast, while the choice of units, repertoires, interventions, and continuity criteria remains subject to domain-specific justification. Such formal objects describe possibilities under specified assumptions; their use does not imply a cardinal measure of domination or flourishing.

A third proposition concerns *the difference between enlarging capabilities and governing their conditions*. An intervention can make additional activities possible while concentrating authority to continue, revise, price, monitor, or discontinue them. This possibility explains why observed benefit, dependence, and legitimacy require distinct assessments. Evaluations of an AI infrastructure, development project, ecological restoration arrangement, or public service can accordingly examine the initial distribution of gains alongside control of ongoing permissions, maintenance, and institutional revision. The relation is contingent: some concentrated arrangements may permit effective accountability and reliable provision, while pluralized arrangements may distribute responsibility poorly or shift substantial maintenance burdens. Comparative assessment should specify the relevant institutional alternatives and the evidence supporting claims about their actual viability.

A fourth proposition concerns *interpretive and normative gateways*. Standards, classifications, evidence rules, communication channels, default settings, and initial protocols can shape which contribu-

tions become recognizable and which complaints become actionable. Control over these interfaces may operate as a form of political-economic influence when it changes access, allocation, reputational standing, or the terms of collective decision. Sections 7 and 9 show why the persons and institutions able to interpret a relation deserve attention alongside those able to alter its physical resources. Their authority can be warranted by expertise, public obligation, or accountable delegation; establishing such warrants requires evidence beyond the interface's technical functionality. The evolution of shared norms that may follow an encounter remains a further question, distinct from the distribution of power over its initial conditions.

A fifth proposition concerns *the material reproduction of contestability*. The practical ability to challenge an arrangement depends on more than a formally announced procedure. Evidence access, information preservation, independent judgment, effective remedies, livelihood security, credible alternatives, and institutional capacity to implement a correction contribute to the exercise of challenge. Section 12 suggests that these requirements can themselves be produced, withheld, concentrated, or displaced through political-economic relations. The proposition predicts neither that additional procedural steps always improve accountability nor that exit is universally preferable to participation. Its usefulness rests on observing who can use different challenge mechanisms, with which consequences, and at whose continuing cost.

Together, these propositions specify a relation between generative capability and authority that remains conceptually open. Participants can possess a capacity to contribute, acquire control over the continuation of another's contributions, or obtain recognized standing to judge a dispute. The degrees and institutional sources of these capacities need not coincide. The present account proposes that tracing their configuration may reveal consequential relations that disappear when production, valuation, and governance are examined independently. The distinctiveness of that proposal remains a hypothesis to be evaluated through comparative explanatory performance.

14.3 Value Circulation and the Conditions of Shared Continuation

The paper's account of heterogeneous value begins with the possibility that productive participation generates outcomes valued through partially different practices, institutions, and forms of life. Revenue, knowledge, ecological renewal, livelihood continuity, social recognition, institutional legitimacy, and new capacities for inquiry may matter in distinct ways. Their relations can be investigated through the processes by which outputs are appropriated, represented, exchanged, converted, returned, or withheld. A conversion interface can expand cooperation by facilitating exchange or interpretation; it can also create an asymmetry when one participant determines the criteria by which others' contributions become recognized and compensable. Section 6 therefore treats the governance of conversion as part of the political economy of value, while leaving its justification to relevant ethical, institutional, and contextual arguments.

This orientation also permits a more exact account of *return*. In some settings, a portion of generated resources, authority, infrastructure, or knowledge may be reinvested in the conditions that enable contributors and affected communities to continue participating. Whether such circulation is adequate depends on whose requirements count, which obligations are enforceable, and whether the return materially sustains the selected capabilities. A monetary transfer may improve access while leaving essential control concentrated elsewhere; conversely, shared knowledge or maintenance rights may preserve capabilities whose significance is poorly represented by market prices. The guiding question is how benefits, decision rights, and reproductive burdens are arranged over time, rather than the maximization of a single measure of generative value. This inquiry draws inspiration from existing generative-justice scholarship while preserving its own limited comparative proposal.

Across human-AI systems, these questions direct attention to distributed labor, data, computation, energy, proprietary services, deployment interfaces, and the institutional conditions of user and worker participation. Across multispecies contexts, they direct attention to environmental reproduction, livelihood effects, forms of legal or political representation, and the limits of translating ecological changes

into humanly administered indicators. The two settings can sometimes share questions about dependence, allocated costs, and interpretive control. Their relevant agencies, capacities, vulnerabilities, and claims to consideration nonetheless require different empirical and philosophical accounts. The hypothetical extraterrestrial reversal sharpens an additional normative challenge: benefits provided by a more powerful actor do not alone settle that actor's entitlement to govern the recipient's continuing conditions. As a stipulated comparison, the reversal can test the consistency of an argument about authority; it supplies no observation of extraterrestrial relations.

A political economy of shared continuation would therefore examine both the productive contributions made possible through cooperation and the arrangements under which affected participants can influence, sustain, and transform that cooperation. Such a perspective leaves space for genuine disagreement. Participants may differ in the outcomes they seek, the forms of knowledge they trust, and the burdens they are willing or entitled to bear. Institutions can provide conditions for negotiation, coexistence, and correction without demonstrating that the values of all participants can be translated into one evaluative language. Cases of failed translation and unresolved conflict are relevant findings, and their consequences should remain visible in comparative reporting.

14.4 Contestability, Representation, and Institutional Reconfiguration

The governance implications of the argument are conditional and institutional rather than a prescription for one universal model of ownership or control. An assessment of a specific arrangement can begin by reconstructing material dependencies and intervention capabilities, then examine who controls interpretation, how affected positions are represented, and which avenues exist for challenge and remedy. The sequence helps distinguish nominal rights from effective practices and short-term improvements from the burdens needed to preserve them. It also enables evaluation of institutional alternatives on their actual terms: public service provision, cooperative ownership, interoperable infrastructures, independent review, distributed maintenance, negotiated stewardship, and other arrangements may each alter some relations of dependence while leaving others intact. Their evaluation requires attention to legal competence, technical constraints, financing, ecological effects, and historical context.

Representation presents a particularly demanding problem where affected units differ in communicative capacities and institutional standing. The interests of workers, users, communities, animals, and ecological processes may become visible through interviews, labor institutions, public participation, scientific observation, legal guardianship, or other arrangements. Each channel can improve legibility while creating a role for intermediaries who select and interpret evidence. Questions of mandate, challenge, methodological uncertainty, and responsibility therefore accompany the act of representation. For artificial systems, records of behavior and operating requirements may identify consequential constraints without settling consciousness, moral status, or independent political claims. For living systems, ecological observation may support responsible stewardship while leaving disputes about value, authority, and obligations open. Evaluating representation requires the methods and norms suited to the particular case.

Institutional reconfiguration also changes the distribution of responsibility. A right to exit can protect some participants while leaving infrastructure maintenance or loss of collective capacity to those who remain. Decentralization can make decisions more locally answerable while assigning technical and organizational work to groups with unequal resources. Independent review can constrain an operator's discretion while relying on specialists whose interpretations remain difficult to challenge. An arrangement's promise should consequently be examined together with its implementation costs, displaced burdens, and possibilities for further revision. The political-economic aim of contestability is best understood here as maintaining conditions under which consequential power can be questioned and corrected according to defensible standards, with the standards themselves open to warranted public criticism.

14.5 Comparative Research Priorities and Criteria of Revision

The next stage of research can proceed through a focused sequence of bounded cases. A first family concerns AI-mediated productive infrastructures, where documentary evidence, permissions, service

dependencies, labor relations, and organizational alternatives can sometimes be studied together. Suitable contrasts might involve access-rule revisions, the adoption of enforceable data-portability provisions, differing maintenance responsibilities, or changes in independent oversight. Investigators could test whether these changes alter practical alternatives, withdrawal vulnerability, distribution of benefits, and effective opportunities for contestation. An inference attributing the changes to discretion or power would still require rival explanations concerning technical scarcity, security duties, service quality, strategic selection, and broader institutional shifts.

A second family concerns ecological and multispecies governance, where the units and outcome concepts should be derived from the specific setting. Comparative work might reconstruct the histories of watershed management, habitat restoration, access restrictions, and recognized forms of representation, using ecological observations alongside livelihood, legal, and institutional records. The objects of comparison would include reproductive effects, allocation of costs, methods of valuation, authority to revise environmental rules, and opportunities for affected communities to contest decisions. Translating these questions across domains should preserve differences in evidence and explanatory mechanisms. Ethical research design also requires attention to the harms that public disclosure, intrusive measurement, or the use of inadequately justified proxies might introduce.

A third research track concerns the measurement and identification of feasible practices. The formal account uses configuration-relative repertoires, joint attainability, interventions, discretionary influence, withdrawal dependence, and horizon-relative continuity to make its assumptions explicit. A case study should identify which of these constructs can be supported by observed records and which remain stipulated possibilities. Simulation may explore specified physical and institutional constraints, while historical reconstruction and confidential testimony can reveal alternatives omitted from administrative records. Identification claims should distinguish intervention effects from correlated change, account for interference and adaptation, and report uncertainty arising from incomplete knowledge of feasible options. The methodological register in Section 13 is intended to support precisely such discriminating study.

The programme should be revised where its proposed concepts fail to distinguish mechanisms, where the selected practices prove irrelevant to affected participants, where nominal options are mistaken for credible ones, or where cross-domain translations erase substantively important differences. Concentration may turn out to matter only under narrower institutional conditions than initially proposed. Alternative governance arrangements may fail to deliver the anticipated continuity or accountability. Important forms of contribution may remain invisible to the selected indicators, and apparently successful remedies may shift their burdens elsewhere. Such outcomes call for redefinition, domain restriction, or rejection of the implicated claims. An explanatory programme gains credibility through its capacity to register these results, including those unfavorable to its initial vocabulary.

14.6 Disciplinary Boundaries and the Prospects for Plural Coexistence

Generative-relational political economy is advanced here as a provisional interdisciplinary specification of established and emerging questions. Political economy contributes analyses of production, labor, ownership, distribution, and the conditions of reproduction; institutional analysis and law examine enforceable arrangements and procedural authority; political philosophy considers justification, freedom, representation, and obligations; ecological and animal studies investigate living relations under their own evidential and ethical standards; and AI research supplies specific knowledge of computational systems and their infrastructures. The present proposal seeks useful correspondences among these approaches while retaining their disagreements and domain-specific concepts. A formal translation between two analyses may be illuminating without establishing that they share one ontology or one metric of value.

The scope of the account is likewise limited within the broader generative-relational research programme. G2 concerns the organization of productive and reproductive conditions, value conversion and circulation, effective discretion, interpretive power, and institutional opportunities for correction. The ontological standing of generative order is a separate object of G1. The formation, transformation, and

coevolution of norms among heterogeneous subjects is a separate object of G3. These interfaces permit future collaboration among lines of inquiry without requiring their immediate synthesis. The provisional designation of a participant as a *subject* remains an analytical convenience whose moral and ontological implications require argument suited to the case. Ontological suspension protects the distinction between the usefulness of a representation and a claim about what ultimately exists.

The resulting perspective is a proposal for examining the conditions under which heterogeneous participants can contribute to and remain involved in evolving relations. It asks whose capacities are sustained, who has discretion to transform the conditions of those capacities, how contributions and costs circulate, whose interpretations acquire authority, and which institutional means make consequential decisions answerable. These questions admit different answers across historical periods, human organizations, artificial infrastructures, and ecological relations. Their common form provides a starting point for comparison; their content must be established through situated evidence and argument. A generative-relational political economy will have demonstrated its value to the extent that it yields sharper explanations, makes neglected dependencies or burdens investigable, and supports more defensible institutional choices while preserving the plurality of the participants and worlds under consideration.

Research Ethics and Source Provenance

Scope. This document contains the complete fourteen-section exploratory first draft of a preliminary discussion. A comprehensive conceptual, empirical, bibliographical, and stylistic review remains outstanding. The proposed formal and empirical research remains prospective. Extraterrestrial encounters are hypothetical thought experiments; no evidence for extraterrestrial subjects or contact is asserted. Present AI systems are discussed as participants in sociotechnical relations without presuming consciousness, legal personhood, or moral status.

Sources. Bibliographic metadata and the specific claims for which sources are cited were checked against publicly accessible publisher or institutional materials before citation. The accompanying verification ledger identifies access limitations, including books verified from publisher descriptions rather than complete text. Full-text and claim-level verification remain necessary for later revision.

Authorship and status. This independent discussion draft was prepared with AI assistance under the human author's research direction. It has not been peer reviewed, and all interpretation and dissemination remain the author's responsibility.

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