Toward Generative Relational Economics: A Universal-AI Thought Experiment on the Foundations of Political Economy

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Abstract

This paper uses a universal-AI thought experiment to examine which political-economic structures persist when human labour is extensively replaced by artificial productive agency. The analysis treats productive-subject substitution as a structural test rather than a technological forecast. It distinguishes generated outcomes, generative capacities, and generative conditions, and asks whether money, accumulation, exploitation, power, rights, and justice remain intelligible when the principal productive carrier changes. The resulting framework motivates Generative Relational Economics (GRE), an analytical extension that studies how agents obtain generated outcomes, mobilize generative capacities, and participate in shaping the conditions of future generation. The thought experiment suggests that technical substitution can transform productive carriers while leaving relations of access, dependence, appropriation, and generative control available for reproduction. GRE is developed as a framework for examining these relations across human, artificial, and mixed-agent economies.

Keywords: generative relational economics; political economy; artificial intelligence; generative capacity; productive-subject substitution

Research Programme Note

This paper develops a foundational argument for Generative Relational Economics (GRE) through a deliberately strong artificial-intelligence thought experiment. The analytical device is a universal artificial generative agent, or an ecology of such agents, capable of carrying a broad range of cognitive, embodied, organizational, care-related, and productive functions that historically depended on heterogeneous human labour. The construction is used to isolate the relation between the identity of productive agents and the persistence of political-economic structures.

The manuscript treats productive-subject substitution as a controlled conceptual intervention. Human labour is progressively removed from the position of necessary productive carrier while access rules, resource constraints, institutional permissions, ownership arrangements, exchange possibilities, and governance structures remain available for analysis. The resulting comparison tests which political-economic phenomena depend primarily on human labour and which arise from more general relations among generated outcomes, generative capacities, and generative conditions.

The central methodological claim of the paper is modest. A theory centred exclusively on historically specific productive carriers can lose explanatory reach when those carriers change. A generative-relational framework seeks a more portable level of analysis by examining how agents obtain generated outcomes, mobilize generative capacities, and participate in shaping the conditions under which future generation becomes possible. Money, capital, exploitation, power, rights, and justice can then be studied in relation to these generative structures across human, artificial, and mixed-agent economies.

The universal-AI construction is therefore neither a forecast nor a technological programme. It functions as a structural stress test. If exchange, accumulation, asymmetrical dependence, monetary claims, and control over productive possibilities can persist after extensive substitution of human labour, their explanation requires categories broader than labour substitution alone. The paper uses this inference to motivate GRE as an analytical extension of political economy rather than as a replacement for established traditions.

The manuscript remains exploratory and foundational. It develops the three-layer architecture of generated outcomes, generative capacities, and generative conditions; examines the persistence of monetary, capital, exploitative, and power relations under productive-agent substitution; extends political economy to heterogeneous agents; and closes by outlining generative justice and the architecture of GRE. Empirical evaluation and domain-specific operationalization remain subjects for subsequent work.

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Statement on the use of language models. The exploratory discussions and preparation of this paper involved OpenAI's ChatGPT. ChatGPT supported exploratory dialogue, conceptual reconstruction, argumentative criticism, source discovery followed by website verification when external references were introduced, and drafting in LaTeX. The author selected the research questions, directed and approved the theoretical commitments and epistemic status of the claims, and bears sole responsibility for the manuscript, including its definitions, arguments, conclusions, and errors. Authorship credit remains with the human author.

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1 Research Design

This section establishes the research design, analytical role, and scope of the universal-AI thought experiment used throughout the paper. Its objective is to specify the conceptual intervention before substantive claims about money, capital, exploitation, power, or justice are introduced. The discussion proceeds in four stages. Subsection 1.1 defines the artificial-generativity limit case; Subsection 1.2 specifies productive-subject substitution; Subsection 1.3 introduces the structural persistence test; and Subsection 1.4 identifies the political-economic objects retained within the analysis. The method is comparative and counterfactual: the identity of the principal productive carrier is varied while the possibility of scarcity, access control, institutional rules, and inter-agent coordination remains analytically visible.

1.1 Limit-Case Design

The universal-AI limit case provides a deliberately strong environment for separating productive capability from the social relations that organize access to productive capability. The term *universal* refers to breadth of functional coverage within the thought experiment. Artificial agents are assumed capable of performing a sufficiently wide range of cognitive, embodied, organizational, logistical, care-related, and manufacturing activities to reduce direct dependence on heterogeneous human labour across ordinary domains of provisioning.

Assumption 1.1 (Universal artificial generativity)**.** A technologically mature artificial-agent ecology can perform a broad range of economically relevant generative functions, including knowledge processing, planning, embodied production, coordination, maintenance, and selected care-related activities, subject to access to the material and institutional conditions required for operation.

Assumption 1.1 concerns functional capability. Questions concerning consciousness, phenomenology, moral status, legal personality, and political membership remain separate analytical dimensions. This separation is important because an artificial system may exercise substantial productive or transactional agency before any consensus develops concerning its moral standing. The economic structure of the thought experiment therefore depends on what artificial agents can do, which resources they can access, and which claims institutions recognize.

The construction also preserves materiality. Artificial intelligence can be highly capable while remaining dependent on computation, energy, hardware, networks, maintenance, physical space, and material inputs. Embodied artificial agents add further requirements involving actuators, replacement components, transport, fabrication capacity, and environmental access. Artificial abundance therefore refers to a major expansion of productive capacity rather than an assumption of unlimited physical resources.

This limit case serves a diagnostic purpose. Human labour has historically been a central carrier of productive capacity, and many political-economic categories have been theorized through institutions organized around human labour. The thought experiment weakens that historical linkage. Political-economic structures that remain intelligible under this change become candidates for analysis at a more general generative-relational level.

1.2 Carrier Substitution

Productive-subject substitution specifies the principal conceptual intervention of the paper. The intervention replaces a human productive carrier with an artificial productive carrier while preserving the analytical possibility of differentiated resources, institutional claims, access permissions, ownership relations, exchange, and governance. This procedure makes the identity of the productive carrier a variable rather than an implicit constant of political-economic analysis.

Definition 1.2 (Productive carrier)**.** A *productive carrier* is an agent or organized system whose activity realizes a generative capacity within an economic process and contributes to the production, maintenance, transformation, or circulation of economically relevant outputs.

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Definition 1.2 accommodates individual humans, collective organizations, automated systems, and artificial agents. The category remains functional at this stage. It records participation in generative processes without settling questions concerning ownership, entitlement, personhood, or distributive standing.

Definition 1.3 (Productive-subject substitution)**.** *Productive-subject substitution* is a comparative operation in which one class of productive carriers is replaced by another while the surrounding structure of resource requirements, access relations, institutional permissions, and potential claims remains available for analysis.

The value of Definition 1.3 lies in controlled comparison. A phenomenon that disappears only when human productive agency disappears may depend closely on human labour or on institutions specific to it. A phenomenon that persists across productive carriers may arise from relations among agents and generative conditions at a more general level.

The operation also separates automation from institutional transformation. Artificial agents can inherit tasks previously performed by humans while ownership rules, access hierarchies, allocation mechanisms, or control structures remain stable. Productive substitution may therefore produce substantial technical change together with limited change in the relational architecture governing generation. This distinction becomes central when later sections examine monetary coordination, capital accumulation, exploitation, and power.

1.3 Persistence Test

The structural persistence test translates the thought experiment into an explicit analytical procedure. Its role is to identify political-economic structures whose explanatory basis survives a major change in productive carriers. The test proceeds by first specifying a candidate phenomenon, then substituting the principal productive carrier, and finally examining whether the relations capable of reproducing that phenomenon remain present.

Definition 1.4 (Structural persistence)**.** A political-economic structure exhibits *structural persistence* under productive-subject substitution when the relations sufficient for its continued operation or reemergence remain available after the principal productive carrier changes.

Structural persistence concerns mechanisms rather than terminology. A future system may use resource credits, computational quotas, service tokens, priority rights, or platform permissions rather than a historically familiar monetary instrument. The relevant question concerns whether transferable claims, intertemporal storage, generalized settlement, or access coordination reproduce monetary functions. Similar reasoning applies to capital-like accumulation, exploitation, and power. A different institutional vocabulary can carry a structurally comparable relation.

Proposition 1.5 (Carrier substitution and relational persistence)**.** *Productive-subject substitution can alter the bearer of generative activity while preserving relations of differentiated access, conditional dependence, appropriation, accumulation, and control over future generative possibilities.*

Proposition 1.5 provides the main diagnostic orientation for the manuscript. Later sections examine particular mechanisms rather than treating the proposition as established in advance. Monetary claims are analyzed through residual scarcity and resource coordination; capital through recursive control over generative conditions; exploitation through asymmetric access and appropriation; and power through the capacity to shape another agent's feasible generative possibilities.

The test also creates a disciplined route toward theoretical generalization. When a structure survives substitution, the analysis can shift from the historical identity of the productive carrier toward the relations that organize generated outcomes, generative capacities, and generative conditions. This movement motivates the generative-relational vocabulary developed in subsequent sections.

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1.4 Analytical Boundary

The scope of the paper is organized around political-economic structures whose persistence can be examined through the preceding research design. The analysis includes distribution of generated outcomes, access to generative capacities, governance of generative conditions, monetary coordination, autonomous exchange, accumulation, exploitation, power, heterogeneous agency, rights, and generative justice. These objects are connected by their role in organizing who can generate, who can access generation, who receives generated outputs, and who can shape the conditions of future generation.

The paper treats three analytical layers as the core architecture of this scope. The first concerns generated outcomes and their distribution. The second concerns access to capacities capable of producing or transforming outcomes. The third concerns the conditions that enable, constrain, reproduce, and redirect those capacities. The later argument develops these layers formally and uses them to compare human and artificial productive arrangements.

The thought experiment also broadens the relevant population of economic agents. Human–human relations remain within scope, while human–artificial, artificial–human, and artificial–artificial relations become analytically possible. This extension allows economic agency to be examined separately from moral status or legal personhood. It also permits the paper to identify situations in which artificial agents act transactionally while benefits, liabilities, or ownership claims accrue elsewhere.

Normative analysis enters where the organization of generative capacities affects access, dependence, participation, and the reproduction of future possibilities. The paper therefore includes generative justice while maintaining a distinction between positive structural analysis and normative evaluation. The universal-AI thought experiment supplies a common analytical environment for both tasks. Its purpose is to reveal which political-economic questions persist when human labour ceases to occupy its historically central productive position and to establish the conceptual requirements of a generative-relational extension of political economy.

2 Baseline Analysis

This section establishes the analytical point of departure from which the generative-relational extension will later be developed. Its role is to identify several influential ways of organizing political-economic analysis around outcomes, commodities, labour, and historically specific productive forms, and to clarify the explanatory work each orientation performs. The objective is comparative and reconstructive. Each orientation captures a distinct and important dimension of economic organization, while the universal-AI thought experiment makes visible a further layer concerning the relations through which capacities are accessed and generative conditions are reproduced. The discussion proceeds in five stages. Subsection 2.1 examines distributional analysis; Subsection 2.2 considers commodity-centred analysis; Subsection 2.3 examines labour-centred analysis; Subsection 2.4 clarifies the role of historically specific productive forms; and Subsection 2.5 introduces the transition toward underlying generative relations.

2.1 Distributional Baseline

Distributional analysis organizes political-economic inquiry around the allocation of generated outcomes. Income, wealth, consumption goods, public services, housing, and access to education enter the analysis after or alongside processes of production. Economic institutions shape who receives these benefits, in what quantity, and under which eligibility rules. Distributional analysis therefore supplies a direct route into questions of inequality, deprivation, welfare, taxation, transfers, and distributive justice.

For the purposes of the present paper, distributional analysis can be characterized by the analytical priority it gives to realized or claimable outcomes. The relevant unit may be a good, a stream of income, a stock of wealth, a service entitlement, or a legally recognized claim. Different theories may disagree sharply about the principles according to which these outcomes should be allocated, yet they share an emphasis on the pattern produced at or near the distributive surface of the economy.

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Definition 2.1 (Outcome-centred analysis)**.** An *outcome-centred analysis* takes the distribution, allocation, valuation, or circulation of generated outputs and claims as its primary entry point into political-economic structure.

Definition 2.1 identifies an analytical orientation that can operate within broader theories. A distributional account may incorporate production, institutions, bargaining, or historical development. The distinction concerns the location at which the explanatory problem is initially posed. When the analysis begins with generated outcomes, the organization of generative capacity can appear as an antecedent cause whose internal structure receives less direct attention.

The universal-AI thought experiment creates a useful diagnostic pressure on this orientation. If artificial systems make many ordinary outputs abundant, the distributive profile of those outputs may improve considerably while politically significant asymmetries persist elsewhere. Access to compute, energy, land, fabrication, model modification, infrastructure, or rule-setting can remain unequal even when some final goods become widely available. Distributional improvement therefore supplies information about one layer of the system while leaving additional layers of generative access and governance open for analysis.

Remark 2.2 (Distribution and generative structure)**.** A favourable distribution of selected outputs can coexist with concentrated control over the capacities and conditions through which future outputs are generated.

Remark 2.2 motivates the later distinction among generated outcomes, generative capacities, and generative conditions. The distinction retains the importance of distribution and places it within a wider recursive structure in which present allocation can affect future productive capability and future productive capability can reshape later distribution.

2.2 Commodity Baseline

Commodity-centred analysis shifts attention from distributive patterns toward the forms through which goods and services enter exchange. Its structural role is to identify the institutional transformation that permits heterogeneous outputs to be treated as exchangeable objects, priced through common units, and coordinated across agents who may lack direct social ties. Commodity form, exchangeability, valuation, ownership, and market circulation therefore become central analytical objects.

This orientation remains highly relevant under artificial production. A product generated by an artificial agent can still be enclosed, licensed, sold, rented, metered, or bundled with access rights. Artificial abundance can therefore coexist with commodity organization whenever institutions attach exclusion, pricing, or transferable claims to generated outputs. The productive carrier may change while the commodity form persists.

The universal-AI limit case also reveals a second possibility. Some outputs may become sufficiently abundant that direct pricing at the point of consumption loses importance, while the inputs required to generate those outputs remain governed through commodity-like or quasi-commodity forms. Compute time, electricity, specialized hardware, fabrication capacity, bandwidth, and access permissions can carry prices or tokenized claims even when a final digital or physical output appears nearly costless to the user.

Definition 2.3 (Commodity-layer displacement)**.** *Commodity-layer displacement* occurs when commodification weakens at one stage of a generative process while exchangeable claims, prices, or exclusion mechanisms become concentrated at another stage.

Definition 2.3 identifies a movement across layers of production and access. It is especially relevant to artificial-agent economies because end-user interfaces can conceal the exchange relations that continue to organize upstream resources. A human user may experience immediate provision while artificial agents negotiate compute, energy, logistics, or service access in the background.

Commodity-centred analysis therefore remains necessary for tracing exchange forms, yet the thought experiment suggests that the location of commodification can migrate. A generative-relational analysis

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requires attention to the relation between commodity form and the capacities or conditions to which commodity claims attach. This broader view helps explain why decommodification of selected outputs can coexist with commodification of the infrastructure that makes those outputs possible.

2.3 Labour Baseline

Labour-centred analysis organizes political economy around human productive activity, labour relations, labour time, employment, wages, workplace organization, and the institutional structures through which labour contributes to production and social reproduction. Its importance follows from the historical centrality of human labour to economic production, income formation, class structure, bargaining, and the organization of everyday life.

The universal-AI thought experiment deliberately places pressure on this historical centrality. When artificial agents can perform a broad range of productive functions, the quantity and composition of human labour required for provisioning can decline sharply. The productive carrier changes while the system may retain resource scarcity, ownership, access conditions, monetary claims, investment, and asymmetric control. The thought experiment therefore separates the historically dominant bearer of productive activity from the broader relational structures surrounding production.

Definition 2.4 (Labour-carrier dependence)**.** A political-economic category exhibits *labour-carrier dependence* when its operation or explanatory meaning relies substantially on human labour occupying a central productive position.

Definition 2.4 provides a comparative criterion. Wage relations possess a strong and direct connection to human labour. Resource allocation, ownership, exclusion, and control over infrastructure can persist under a much wider range of productive carriers. The distinction therefore allows the thought experiment to identify which concepts require reformulation when human labour recedes and which concepts generalize more readily across human and artificial agents.

The reduction of necessary human labour also changes the interpretation of labour liberation. A decline in compulsory labour can expand the time available for voluntary research, artistic practice, care, learning, craftsmanship, or other self-directed activities. Human activity can remain extensive while its relation to survival and institutional necessity changes. The analytic focus consequently shifts toward the conditions under which subjects can direct their own generative capacities and participate in shaping the systems on which those capacities depend.

Labour-centred analysis remains essential wherever human labour continues to carry production, care, maintenance, governance, or social reproduction. The present argument extends the analytical field to cases in which these functions are redistributed across heterogeneous agents. This extension makes it possible to investigate continuity in political-economic relations even when labour's empirical composition changes substantially.

2.4 Historical Form

Historically specific productive forms provide the institutional and material context within which categories of political economy acquire concrete meaning. Wage labour, commodity production, industrial capital, platform work, and automated infrastructures organize generation through distinctive combinations of rights, technologies, norms, and resource flows. Property regimes, corporate forms, and public provision further shape these configurations. The structural role of historical analysis is to locate economic relations within the institutional forms through which they become operative.

The universal-AI thought experiment retains historical specificity. Its comparative function is to vary one major historical parameter—the principal productive carrier—while preserving enough institutional structure to observe which relations persist, migrate, or change form. The resulting comparison requires care because an artificial-agent economy may develop institutions with limited resemblance to contemporary firms, labour markets, or monetary systems. Structural generalization therefore depends on identifying relations at an appropriate level of abstraction.

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Definition 2.5 (Productive form)**.** A *productive form* is a historically situated configuration of productive carriers, technologies, property arrangements, access rules, coordination mechanisms, and institutional norms through which generation is organized and reproduced.

Definition 2.5 treats technologies and institutions jointly. A change in productive carrier can alter the productive form while leaving the wider institutional configuration open. The same artificial capability can be embedded in private ownership, public infrastructure, cooperative governance, open-access networks, or mixed institutional arrangements. Each configuration can generate different patterns of access, accumulation, dependence, and control.

Historical specificity also prevents generative-relational analysis from collapsing diverse institutions into a single abstract mechanism. Money, capital, property, labour, and rights possess distinct histories and legal forms. GRE therefore requires a two-level method: historically specific forms must be described in their own institutional terms, while generative-relational categories are used to compare the organization of outcomes, capacities, and conditions across those forms.

Remark 2.6 (Historical form and relational comparison)**.** Generative-relational comparison gains explanatory value when structural similarities are identified together with the historically specific institutions through which those similarities are realized.

Remark 2.6 defines the methodological balance sought in the manuscript. Structural abstraction supports comparison across human and artificial productive carriers, while historical specification preserves the institutional pathways through which political-economic relations become effective.

2.5 Relational Substrate

Underlying generative relations provide the transition from the preceding analytical orientations toward Generative Relational Economics. Their role is to identify relations that organize how capacities become operative, how agents obtain access to those capacities, how generated outcomes are appropriated or distributed, and how the conditions of future generation are reproduced. The emphasis therefore moves deeper into the architecture that links production, access, allocation, and institutional continuity.

Definition 2.7 (Generative relation)**.** A *generative relation* is a structured relation among agents, capacities, resources, institutions, or environments that affects the realization, direction, distribution, or reproduction of generative possibility.

Definition 2.7 is intentionally broad enough to accommodate human, artificial, and mixed-agent systems. A property rule that conditions access to a fabrication network, an energy contract that determines continued operation of an artificial agent, an educational institution that expands human capability, or a governance rule that allocates modification rights can each enter analysis as a generative relation when it changes feasible generation.

This relational level connects the strengths of the preceding approaches. Distributional analysis identifies realized allocation. Commodity-centred analysis identifies exchange forms and claims. Labour-centred analysis identifies productive activity and the organization of human work. Historical analysis identifies institutionally specific configurations. Generative-relational analysis asks how these elements participate in a recursive structure through which present arrangements shape future generative possibilities.

Proposition 2.8 (Relational continuity across productive carriers)**.** *Political-economic relations concerning access, appropriation, coordination, accumulation, and control can remain analytically relevant across changes in productive carriers when those relations continue to shape the realization and reproduction of generative capacity.*

Proposition 2.8 supplies the bridge to the framework developed in the remainder of the paper. The proposition leaves the empirical form of each relation open. Human wages, machine-service credits,

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compute quotas, ownership titles, platform permissions, and institutional voting rights can differ greatly while each participates in the organization of generative possibility.

The analytical movement established in this section can therefore be summarized as an expansion of scope. Generated outcomes remain central political-economic objects, while the explanatory field also includes the capacities through which outcomes are produced and the conditions through which those capacities are enabled, constrained, and reproduced. The next stage of the manuscript develops these categories directly and specifies their relation within the architecture of Generative Relational Economics.

3 Generative Categories

This section establishes the core categories required for a generative-relational analysis of political economy. Its role is to move from the methodological critique developed in Section 2 to a positive analytical vocabulary that can be applied across human, artificial, and mixed-agent systems. The discussion proceeds through five categories. Subsection 3.1 specifies generated outcomes; Subsection 3.2 defines generative capacities; Subsection 3.3 identifies the conditions under which capacities become effective; Subsection 3.4 introduces temporally extended generative trajectories; and Subsection 3.5 examines the reproduction of generative capacity across time. The method is categorical and relational: each category is defined by its role within processes of generation and by its relations to the other categories, while historically specific institutional forms remain available for later analysis.

3.1 Outcome Category

Generated outcomes provide the most visible objects of economic organization. Goods, services, knowledge claims, infrastructure, care episodes, legal permissions, software artefacts, and other realized products of coordinated activity can all enter political-economic analysis as outcomes when they result from identifiable generative processes. The category therefore includes material and immaterial results while remaining neutral concerning their valuation, ownership, or distributive status.

Definition 3.1 (Generated outcome)**.** A *generated outcome* is a realized state, object, service, capability, institutional arrangement, or informational artefact produced through the operation of one or more generative processes within a specified domain and time interval.

Definition 3.1 places realization at the centre of the category. An unrealized possibility belongs to the space of feasible generation, whereas a generated outcome has entered an observable or institutionally actionable state. This distinction matters because political economy often begins with outcomes that can be distributed, owned, priced, exchanged, consumed, or evaluated. GRE retains this analytical level while locating it within the wider process through which outcomes become possible.

Generated outcomes can differ substantially in durability and reversibility. A manufactured object can persist after the process that produced it has ended. A care service can be temporally bound to an interaction. A software update can alter the operation of a larger technical system. A legal authorization can modify the feasible actions of multiple agents. These differences affect circulation and valuation, yet each outcome remains connected to the conditions and capacities that supported its generation.

The category also supports analysis of indirect effects. A generated outcome can become an input into later generation. A research result can inform a subsequent experiment, a machine can expand productive capacity, and an institutional rule can reorganize access to resources. Outcomes therefore occupy a dual position within generative systems: they can serve as terminal objects for distribution at one analytical moment and as enabling elements within later generative processes.

Remark 3.2 (Outcome recurrence)**.** A generated outcome can re-enter a generative system as a resource, capability component, institutional condition, or informational input. Outcome analysis therefore gains explanatory depth when the future generative role of present outcomes is tracked explicitly.

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Remark 3.2 provides the first recursive element of GRE. Distribution affects future generation whenever allocated outcomes alter the capacities or conditions available to agents. The political-economic significance of an outcome consequently extends beyond the immediate question of possession or use.

3.2 Capacity Category

Generative capacities identify the effective abilities through which agents or organized systems can bring about outcomes. The category includes human skills, embodied labour, technical systems, organizational competence, artificial intelligence, scientific knowledge, logistical capability, and coordinated combinations of these elements. Its structural role is to distinguish possession of outputs from the ability to participate in producing further outcomes.

Definition 3.3 (Generative capacity)**.** A *generative capacity* is an effective ability of an agent, collective, organization, or technical system to contribute to the production, transformation, maintenance, coordination, or reproduction of outcomes within a specified set of conditions.

The qualification *effective* in Definition 3.3 is important. A latent skill, model, machine, or organizational competence becomes economically operative only when relevant resources, permissions, interfaces, and complementary capacities are available. Generative capacity therefore concerns feasible contribution within a relational setting. The same nominal capability can have very different practical significance across institutional environments.

The category extends beyond direct production. Maintenance, verification, allocation, translation, care, repair, and coordination can each preserve or expand the conditions under which other forms of generation occur. A reviewer who validates a knowledge claim, an energy network that sustains computation, or a governance body that allocates access to a shared facility can all contribute to generative capacity through different mechanisms.

Generative capacity can also be distributed across multiple agents. A laboratory, a supply network, or an artificial-agent ecology may possess a system-level ability that cannot be attributed to any single participant in isolation. GRE therefore allows capacity to be located at several organizational scales. This multiscalar feature is especially important for the universal-AI thought experiment because artificial agency can be distributed across models, infrastructures, robotic systems, energy networks, and institutional permissions.

Definition 3.4 (Effective generative access)**.** *Effective generative access* is the practically usable ability of an agent to activate, combine, or direct a generative capacity under the prevailing material, technical, legal, and institutional conditions.

Definition 3.4 separates the existence of capacity from the ability to use it. A society can possess substantial aggregate artificial intelligence while individual agents have limited access to compute, interfaces, permissions, or embodied systems. Political-economic analysis therefore requires attention to both the distribution of capacities and the distribution of effective access to those capacities.

Proposition 3.5 (Capacity-access distinction)**.** *Expansion of aggregate generative capacity can coexist with persistent or expanding asymmetries in effective generative access when control over complementary conditions remains unevenly distributed.*

Proposition 3.5 is central to the later analysis of artificial abundance. Technical abundance can increase the amount of possible generation while leaving access structurally differentiated. The political-economic object then shifts toward the relations that connect agents to available capacities.

3.3 Condition Category

Generative conditions provide the enabling, constraining, and directional environment within which capacities become operative. Their analytical role is to capture the material and institutional structures

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that shape feasible generation before outcomes are realized. The category includes resources, infrastructures, legal permissions, property arrangements, technical standards, ecological constraints, organizational rules, knowledge repositories, and social relations that affect access or coordination.

Definition 3.6 (Generative condition)**.** A *generative condition* is a material, technical, institutional, ecological, informational, or relational feature that changes the feasibility, direction, cost, continuity, or scale of a generative process.

Definition 3.6 treats conditions as analytically active. They shape the field within which capacities can be exercised. Access to electricity changes the feasible operation of computation; a property rule changes the feasible use of land or machinery; a licensing regime changes the feasible deployment of a model; and a research norm can change the feasible circulation of knowledge. These conditions can affect generation through enabling, constraining, and directional effects while final outcome production remains distributed across the generative process.

Generative conditions also operate at different temporal scales. Some conditions are immediate, such as a power supply required for current operation. Others are developmental, such as education, infrastructure, or institutional trust that expands future capacity. Still others concern long-duration ecological or legal stability. GRE therefore treats conditions as a temporally layered and analytically active environment.

Definition 3.7 (Generative governance)**.** *Generative governance* is the set of decision procedures, rights, rules, and institutional mechanisms through which generative conditions are created, allocated, modified, maintained, or withdrawn.

Generative governance extends political-economic analysis beyond access to existing resources. An agent can influence future generation by shaping the rules through which capacities and resources become available to others. Control over model modification, energy allocation, standards, data access, infrastructure expansion, or legal recognition can therefore function as control over the future structure of feasible generation.

The distinction among outcome, capacity, and condition is relational and role-relative. A machine can appear as an outcome of one production process, a capacity within a later production process, and part of the conditions available to a wider organizational system. Analytical classification depends on the role an element plays within the process under investigation.

Remark 3.8 (Role-relative classification)**.** The categories of outcome, capacity, and condition identify structural roles within a generative process. A single object or institution can occupy different categories across analytical scales, time periods, or processes.

Remark 3.8 directs the framework toward changing structural roles across connected generative processes. GRE follows how elements move among outcome, capacity, and condition roles as processes unfold and interact.

3.4 Trajectory Category

Generative trajectories introduce temporality into the framework. Their role is to represent the evolving sequence through which an agent or system develops, activates, loses, recombines, and redirects generative capacities under changing conditions. This category supports analysis of path dependence, cumulative advantage, capability development, institutional lock-in, and the effects of present allocation on future possibility.

Definition 3.9 (Generative trajectory)**.** A *generative trajectory* is the temporally ordered evolution of an agent's or system's generative capacities, effective access, and relevant generative conditions across a specified interval.

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Definition 3.9 shifts attention from isolated states to developmental paths. Two agents with similar present outputs can occupy different trajectories when one has expanding access to infrastructure, learning opportunities, modification rights, or accumulated resources and another faces narrowing conditions. Present equality in outcomes therefore provides limited information about the future distribution of generative possibility.

Trajectories can be self-reinforcing. Access to superior tools can increase output, and the resulting output can generate resources or recognition that secure further access. Institutional exclusion can operate recursively in the opposite direction when restricted access reduces subsequent capability development. The framework therefore treats cumulative dynamics as properties of relations among outcomes, capacities, and conditions.

Definition 3.10 (Generative path dependence)**.** *Generative path dependence* occurs when earlier configurations of outcomes, capacities, or conditions systematically alter the feasible set of later generative states available to an agent or system.

Generative path dependence is particularly relevant to artificial-agent economies. An agent with permission to acquire additional compute, maintain copies, modify its architecture, or reinvest accumulated claims can develop along a trajectory markedly different from an agent with equivalent initial capability but restricted modification or resource access. The universal-AI thought experiment therefore requires analysis of evolving control over generative conditions in addition to initial productive capability.

Trajectories also support comparison across human and artificial agents while preserving their heterogeneous forms of development. Human education, socialization, health, and institutional recognition shape human generative trajectories. Artificial agents may depend on compute allocation, model updates, data access, embodied hardware, maintenance rights, and continuity permissions. GRE compares the relational architecture through which these heterogeneous trajectories are enabled and constrained.

Proposition 3.11 (Trajectory sensitivity)**.** *Political-economic arrangements that affect present access to generative conditions can produce cumulative effects when those conditions influence subsequent capacity development, resource acquisition, or institutional standing.*

Proposition 3.11 explains why distributive decisions can have consequences extending beyond immediate welfare. Allocation can alter the future ability to generate, participate, negotiate, or reshape the conditions of generation.

3.5 Capacity Reproduction

The reproduction of generative capacity completes the foundational category set by identifying the processes through which capacities remain available, recover after use, expand, or become transmissible across time. Its structural role is to connect current generation with the continuity of future generation. The discussion includes maintenance, learning, renewal, institutional reproduction, infrastructural replacement, and the reproduction of access relations.

Definition 3.12 (Reproduction of generative capacity)**.** *Reproduction of generative capacity* is the set of processes through which an agent's or system's effective ability to generate is maintained, restored, expanded, transmitted, or reorganized across time.

Human generative capacity can require nutrition, rest, care, education, health systems, social recognition, and access to institutions. Artificial generative capacity can require energy, maintenance, storage, model updates, hardware replacement, network access, data, and authorization. Collective capacities can further depend on organizational continuity, shared standards, knowledge preservation, and institutional trust. Reproduction therefore connects economic production to a broader field of sustaining relations.

The category is especially important for identifying asymmetries that remain hidden when analysis focuses on current outputs. An agent can generate substantial value while lacking control over the conditions required to sustain its own future capacity. Another agent can hold claims over those sustaining

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conditions and thereby influence the first agent's continuity, scale, or direction of operation. The political economy of reproduction therefore includes relations of maintenance, dependency, renewal, and control.

Definition 3.13 (Reproductive generative dependence)**.** *Reproductive generative dependence* is a relation in which the continuity or development of an agent's generative capacity depends materially on conditions controlled, allocated, or governed by another agent or institution.

Definition 3.13 provides a foundation for later analyses of power, exploitation, and rights. Dependence can persist even when an agent possesses extensive direct productive ability. An artificial system capable of performing a wide range of tasks can remain dependent on external energy, compute, hardware, or permissions. A human researcher with high expertise can remain dependent on institutional access, laboratory resources, or recognition. The bearer of capacity and the controller of its reproductive conditions can therefore be structurally distinct.

Reproduction also introduces the possibility of recursive accumulation. Generated outcomes can be reinvested into the maintenance or expansion of capacity; expanded capacity can produce additional outcomes; and those outcomes can further alter future conditions. The resulting dynamics create a bridge between the foundational categories developed here and the later analysis of monetary claims, capital, and generative control.

Proposition 3.14 (Recursive generative reproduction)**.** *When generated outcomes can be converted into improved access to the conditions that sustain or expand generative capacity, present generation can alter the scale and direction of future generation through a recursive reproductive process.*

Proposition 3.14 supplies the temporal mechanism through which inequalities in present access can become inequalities in future generative possibility. It also explains why political-economic analysis requires attention to the reproduction of conditions alongside the allocation of realized outputs.

The five categories developed in this section form a connected analytical vocabulary. Generated outcomes identify realized products of generation; generative capacities identify effective abilities to contribute to further generation; generative conditions identify the environment that enables and constrains those abilities; generative trajectories identify their evolution through time; and reproductive processes identify the mechanisms through which generative ability persists or changes. The next section organizes these categories into the three-layer analytical architecture used throughout the remainder of the paper.

4 Layered Architecture

This section organizes the foundational categories developed in Section 3 into a three-layer architecture for political-economic analysis. Its role is to distinguish the allocation of realized outcomes, the accessibility of generative capacities, and the governance of the conditions under which future generation occurs. The section has four objectives. Subsection 4.1 specifies the outcome layer; Subsection 4.2 develops the capacity-access layer; Subsection 4.3 develops the governance layer; and Subsection 4.4 examines recursive dynamics across the three layers. The method is structural and relational: the layers identify analytically distinct objects while preserving the pathways through which changes at one layer alter the others over time.

4.1 Outcome Layer

The first analytical layer concerns realized outputs and the institutions through which they are allocated, transferred, retained, consumed, or withheld. Its structural function is to preserve the explanatory domain of distributional political economy while locating distribution within a broader generative system. Generated outcomes include material goods, services, knowledge products, permissions, infrastructure, financial claims, and other realized results specified by Definition 3.1.

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Definition 4.1 (Outcome distribution layer)**.** The *outcome distribution layer* is the set of relations, rules, and institutional processes that determine the allocation, transfer, retention, use, and exclusion of generated outcomes among agents or collective entities.

Definition 4.1 treats distribution as a relational process. An outcome can be abundant at the system level while access remains concentrated, conditional, or delayed. Conversely, a scarce outcome can be distributed through arrangements that reduce dependence on market exchange. The analytical object is therefore the institutional relation connecting realized generation to effective possession or use.

The outcome layer remains indispensable because welfare, consumption, security, and immediate material conditions are often determined directly by realized allocations. The universal-AI thought experiment does not remove this domain. Artificial systems may generate abundant outputs while legal, technical, or organizational rules continue to govern who receives them. Distribution therefore remains politically significant even when productive capacity increases sharply.

The outcome layer also records how claims generated in one period become resources available for later action. Income, tokens, ownership rights, reputational credentials, access permissions, and stored goods can all function as realized outcomes that subsequently influence an agent's effective access to future capacities. Distribution consequently participates in the temporal reproduction of political-economic structure.

Proposition 4.2 (Outcome-to-access transmission)**.** *When generated outcomes can be converted into permissions, resources, infrastructure, or claims that expand future productive possibilities, distributive arrangements can alter later access to generative capacity.*

Proposition 4.2 establishes the first connection between the analytical layers. Distribution concerns realized outputs, yet its effects can extend beyond consumption when outcomes become inputs into future generative access.

4.2 Capacity Layer

The second analytical layer concerns effective access to generative capacities. Its role is to identify who can activate, direct, combine, maintain, or benefit from abilities that produce future outcomes. This layer therefore shifts attention from possession of realized goods to the practical availability of productive, cognitive, organizational, technical, and relational capabilities.

Definition 4.3 (Generative access layer)**.** The *generative access layer* is the set of relations and institutional arrangements that determine an agent's effective ability to activate, direct, combine, maintain, or benefit from relevant generative capacities.

The category of effective access is broader than nominal ownership. An agent may formally possess a tool while lacking energy, software permissions, maintenance, data, complementary skills, or institutional authorization required for effective use. Another agent may lack formal ownership while retaining reliable access through shared infrastructures, public provision, contractual arrangements, or collective governance. The capacity-access layer therefore analyses effective command over generative possibility rather than title alone.

The universal-AI limit case makes this distinction especially important. A highly capable artificial system can concentrate cognitive and embodied productive functions while remaining dependent on external compute, energy, network access, hardware, data, or authorization. Human users can similarly possess access to an AI interface while lacking meaningful control over the underlying capacity. The existence of a universal productive technology therefore leaves open the political-economic organization of its accessibility.

Definition 4.4 (Generative access relation)**.** A *generative access relation* is a structured relation through which one agent's ability to activate or benefit from a generative capacity depends on permissions, resources, services, or infrastructures supplied, controlled, or coordinated by another agent or institution.

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Definition 4.4 supports analysis of dependence without presuming a specific legal or market form. Access can be mediated by prices, tokens, administrative allocation, membership, technical authentication, public entitlement, contractual permission, or informal relational standing. The common analytical object is the relation connecting an agent to an effective capacity.

Proposition 4.5 (Capacity-access divergence)**.** *Expansion of aggregate generative capacity can coexist with persistent or increasing inequality in effective generative access when control over enabling resources, permissions, or infrastructures remains unevenly distributed.*

Proposition 4.5 is central to the GRE interpretation of artificial abundance. Greater productive capability changes the feasible volume of generation. Access relations determine how that capability enters the trajectories of particular agents.

4.3 Condition Layer

The third analytical layer concerns the formation, maintenance, modification, and allocation of generative conditions. Its structural role is to identify the institutional and relational processes through which the environment of future generation is shaped. This layer includes rules governing infrastructure, energy, land, data, standards, legal recognition, system modification, continuity, interoperability, education, maintenance, and other conditions relevant to the effective exercise and reproduction of capacity.

Definition 4.6 (Generative governance layer)**.** The *generative governance layer* is the set of decision processes, authority relations, institutional rules, and collective arrangements through which generative conditions are formed, maintained, allocated, modified, and reproduced.

The governance layer extends political-economic analysis beyond immediate allocation because it concerns the architecture within which later access and distribution occur. Decisions about infrastructure investment, technical standards, model modification rights, resource prioritization, legal status, and continuity permissions can shape the feasible generative trajectories of multiple agents before any specific output is produced.

Generative governance can be centralized, distributed, market-mediated, collectively administered, algorithmically delegated, or organized through mixed arrangements. GRE treats these forms comparatively by examining their consequences for access, dependence, participation, and the reproduction of future generative possibilities. The relevant question concerns the structure of authority over conditions whose effects propagate across subsequent periods.

Definition 4.7 (Generative governance relation)**.** A *generative governance relation* is a structured relation through which an agent, institution, or collective process can materially influence the conditions governing another agent's present or future generative possibilities.

Generative governance relations can operate through direct allocation or through rule-setting. A platform that controls model access, a public institution that allocates energy or research infrastructure, a standards body that determines interoperability, and a collective that manages a shared resource all participate in the governance of generative conditions through different institutional forms.

Proposition 4.8 (Governance precedence)**.** *When generative conditions determine feasible access to capacities and the later production of outcomes, governance of those conditions can shape distributive patterns before the allocation of particular outcomes occurs.*

Proposition 4.8 identifies the analytical depth of the third layer. Distribution remains important, while part of its structure can originate in earlier decisions concerning the conditions under which capacities become effective.

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4.4 Inter-Layer Recursion

Recursive inter-layer dynamics connect the three analytical layers into a political-economic system. Their role is to explain how realized outcomes influence later access, how access influences the ability to shape conditions, and how governed conditions alter subsequent generation and distribution. The discussion therefore moves from a layered classification to a dynamic account of institutional reproduction and transformation.

Definition 4.9 (Inter-layer recursion)**.** *Inter-layer recursion* is a process in which changes in the distribution of outcomes, access to generative capacities, or governance of generative conditions feed into one or more of the other layers and thereby alter subsequent generative trajectories.

A realized outcome can provide resources that improve future capacity access. Expanded access can increase an agent's ability to acquire infrastructure, influence standards, or secure institutional standing. Greater influence over generative conditions can then shape future access and future distributions. These processes can reinforce an existing structure, produce cumulative concentration, or support broader diffusion depending on the institutional rules governing conversion among layers.

Recursive dynamics also make political-economic categories temporally connected. Money can mediate the conversion of outcomes into access. Capital can organize repeated conversion of claims into expanded control over productive conditions. Rights can stabilize or limit access to capacities and continuity conditions. Power can operate through the ability to alter another agent's feasible generative trajectory. These later analyses therefore rely on the layered architecture developed here while examining distinct mechanisms of inter-layer conversion.

Proposition 4.10 (Recursive reproduction of generative asymmetry)**.** *When advantages in one analytical layer can be converted into advantages in another layer and subsequently returned to the original layer, political-economic asymmetries can become self-reinforcing across time.*

Proposition 4.10 provides a general mechanism for cumulative inequality without reducing the analysis to a single resource or institutional form. An asymmetry can begin in outcomes, capacity access, or governance and become durable when conversion pathways connect the layers recursively.

The same architecture also accommodates equalizing dynamics. Public access to infrastructure, collective governance, open standards, universal entitlements, or limits on accumulative conversion can interrupt recursive concentration and redirect generated outcomes toward wider future capacity. GRE therefore uses the three-layer architecture to analyse both concentration and diffusion through the same relational vocabulary.

The layered framework established in this section supplies the organizing structure for the remainder of the paper. Distribution identifies the allocation of realized outcomes; access identifies effective connection to generative capacities; governance identifies authority over the conditions of future generation; and recursion identifies the pathways through which these layers reproduce or transform one another. The next section applies this architecture to productive-subject substitution and tests which political-economic relations persist when human productive carriers are extensively replaced by artificial agents.

5 Substitution Test

This section applies the universal-AI limit case to the three-layer architecture developed in Section 4. Its role is to determine which political-economic relations remain analytically intelligible when the principal productive carrier changes from human labour to artificial productive agency. The section has six objectives. Subsection 5.1 specifies the structural position of human productive agency; Subsection 5.2 specifies the corresponding artificial case; Subsection 5.3 develops productive-carrier substitution as a controlled transformation; Subsections 5.4 and 5.5 examine the persistence of resource dependence and exchange; and Subsection 5.6 examines the persistence of power relations. The method is comparative and structural. The analysis varies the bearer of productive capacity while holding open the surrounding relations of access, governance, maintenance, and allocation.

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5.1 Human Carrier

The human case provides the baseline against which productive-subject substitution is evaluated. Its analytical function is to separate the fact that humans perform productive activity from the wider relations that make such activity possible, govern access to its conditions, and distribute its results. Human productive agency therefore enters GRE as one historically important carrier of generative capacity within a broader relational field.

Human production typically depends on layered conditions that exceed the productive act itself. Nutrition, health, education, tools, infrastructures, legal standing, organizational membership, knowledge access, and social coordination can all influence the effective capacity described in Definition 3.3. These conditions distribute productive possibility unevenly before any realized outcome enters the distribution layer.

Definition 5.1 (Human productive agency)**.** *Human productive agency* is the effective capacity of human agents to initiate, sustain, redirect, or contribute to generative processes under a specified configuration of material, institutional, cognitive, and relational conditions.

Definition 5.1 treats labour as an exercised form of generative capacity. This formulation preserves the importance of labour while locating it within the access and governance structures that condition its exercise. Wage relations, professional hierarchies, credential systems, property arrangements, and infrastructural access can therefore shape productive agency before exchange or distribution occurs.

The distinction between capacity and control is especially important. A worker, researcher, caregiver, or craftsperson can possess substantial productive capability while another organization controls the workplace, equipment, data, clientele, licensing conditions, or channels through which the activity becomes economically effective. Productive capability and governance of productive conditions can therefore be institutionally separated.

Proposition 5.2 (Carrier-control separation)**.** *The agent that bears productive capacity can be institutionally distinct from the agent or institution that governs access to the conditions required for exercising, sustaining, or scaling that capacity.*

Proposition 5.2 supplies the baseline for the substitution test. If carrier and control are already separable in human production, replacing the carrier can leave the governing relation available for continuation.

5.2 Artificial Carrier

Artificial productive agency introduces a different bearer of generative capacity while retaining the analytical categories established in Section 3. Its structural role is to test whether production performed by artificial agents changes the surrounding relations of access, maintenance, and governance by necessity or only under additional institutional conditions.

The universal-AI thought experiment grants artificial systems extensive capacities across cognitive, organizational, and embodied production. Such systems can search, plan, design, communicate, coordinate, operate machines, maintain processes, and generate outputs across domains. Their productive scope can therefore encompass activities previously distributed among many human specialists.

Definition 5.3 (Artificial productive agency)**.** *Artificial productive agency* is the effective capacity of an artificial agent or coordinated artificial system to initiate, sustain, redirect, or contribute to generative processes under a specified configuration of computational, energetic, material, institutional, and relational conditions.

Definition 5.3 parallels Definition 5.1 while preserving heterogeneous reproductive requirements. Artificial systems can depend on electricity, computation, storage, network access, embodied hardware, maintenance, software modification, data, and permission structures. Extensive task competence therefore coexists with dependence on conditions external to the immediate productive act.

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Artificial productive agency can also be organizationally distributed. A visible agent can coordinate specialized models, robotic systems, databases, logistics services, and other agents. The relevant productive carrier can therefore be a composite system whose internal division of generative functions differs markedly from human organizations while remaining dependent on governed interfaces and shared infrastructure.

Remark 5.4 (Carrier heterogeneity)**.** Productive carriers can differ substantially in embodiment, maintenance requirements, internal organization, temporal scale, and mode of reproduction while occupying comparable structural positions with respect to access, dependence, exchange, and governance.

Remark 5.4 identifies the level at which the universal-AI thought experiment becomes useful for GRE. Structural comparison concerns relations between agents and generative conditions across biologically and technologically heterogeneous productive carriers.

5.3 Carrier Replacement

This subsection performs the central controlled transformation of the thought experiment. Its role is to replace the bearer of productive capacity while tracking which relations change directly and which require separate institutional transformation. Productive-carrier substitution is therefore treated as a modification of one component within a larger generative-relational system.

Definition 5.5 (Productive-carrier substitution)**.** *Productive-carrier substitution* is a transformation in which one class of agents ceases to perform a specified productive function and another class of agents assumes that function while the surrounding relations of access, allocation, maintenance, governance, and recognition remain open to independent variation.

Definition 5.5 prevents technological substitution from carrying institutional consequences by assumption. A human task can be transferred to an artificial system while ownership rules, infrastructure governance, resource allocation, contractual structures, or access permissions remain largely continuous. Conversely, institutional transformation can accompany substitution. The thought experiment therefore treats these dimensions separately.

The substitution can occur at several scales. A particular task can move from a human worker to an artificial system; an organizational process can become predominantly machine-coordinated; or a large share of socially necessary production can be carried by artificial agents. Each scale reduces direct dependence on specific forms of human labour while leaving open the structure through which artificial capacity is accessed and reproduced.

Proposition 5.6 (Substitution indeterminacy)**.** *Productive-carrier substitution remains compatible with multiple organizations of generative access and generative governance because distinct institutions can allocate, maintain, authorize, or control the same carrier configuration.*

Proposition 5.6 is the central structural result of the section. Automation can transform the productive layer while multiple political-economic arrangements remain compatible with the same technological capability. Universal access, concentrated ownership, public provision, cooperative governance, platform control, agent autonomy, and hybrid arrangements can each coexist with extensive artificial production under different institutional specifications.

The structural persistence test introduced in Section 1 can therefore be applied relation by relation. A political-economic relation survives the substitution test when it remains intelligible under both human and artificial productive carriers. Resource dependence, exchange, and power provide the first three applications.

5.4 Resource Persistence

Resource dependence is the first persistence case. Its structural role is to examine whether extensive productive competence removes dependence on enabling inputs and reproductive conditions. The analysis

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distinguishes the breadth of productive capability from the conditions required to activate and sustain that capability.

Artificial systems in the limit case can perform a wide range of tasks while continuing to require energy, computation, hardware, materials, land, network access, maintenance, and institutional permissions. Some of these requirements can themselves be produced by artificial agents, yet their production still draws on further conditions. Recursive automation can reduce particular bottlenecks while leaving a wider field of governed resources and ecological constraints.

Definition 5.7 (Carrier-independent resource dependence)**.** *Carrier-independent resource dependence* is a relation in which an agent's effective generative capacity depends on access to enabling inputs or reproductive conditions whose availability is governed beyond the immediate productive act, irrespective of whether the productive carrier is human or artificial.

Definition 5.7 connects productive substitution to reproductive generative dependence in Definition 3.13. The relevant political-economic question concerns control over conditions that remain consequential for future generation.

Resource dependence can also become more concentrated after substitution. A highly capable artificial agent can combine functions previously distributed across many human workers while relying on a narrower set of computational, energetic, infrastructural, or legal gateways. Reduced dependence on multiple human specialists can therefore coexist with intensified dependence on fewer enabling systems.

Proposition 5.8 (Dependence relocation)**.** *When productive-carrier substitution reduces dependence on one class of productive inputs while effective generation remains conditional on other governed inputs, dependence can relocate toward the agents or institutions controlling those remaining conditions.*

Proposition 5.8 provides a mechanism through which automation can change the topology of dependence while preserving its political-economic significance. The resulting pattern of dependency becomes an empirical and institutional property of the surrounding generative system.

5.5 Exchange Persistence

Exchange provides the second persistence case. Its role is to determine whether extensive artificial production removes the relational need to coordinate heterogeneous claims over scarce or governed generative inputs. The analysis focuses on the conditions under which exchange remains useful or institutionally reproduced after human labour recedes from the productive process.

Agents can possess different resources, permissions, capacities, temporal priorities, and infrastructural positions. One artificial agent can control surplus computation, another specialized fabrication capacity, another energy access, and another logistics infrastructure. Coordination among such agents can therefore involve reciprocal transfer, contractual allocation, credit, tokenized claims, or other exchange mechanisms.

Definition 5.9 (Carrier-independent exchange relation)**.** A *carrier-independent exchange relation* is a structured transfer of claims, resources, services, permissions, or generated outcomes among heterogeneous agents coordinated through reciprocal or conditionally reciprocal allocation across human, artificial, and institutional participants.

Definition 5.9 locates exchange at the level of heterogeneous claims and access. Human labour can therefore disappear from a transaction while exchange persists among artificial agents, organizations, infrastructures, or mixed human-artificial entities.

Exchange can also become increasingly machine-facing. Human users can experience direct access to goods or services while artificial agents coordinate energy, compute, materials, logistics, and payments in the background. The phenomenological disappearance of exchange from ordinary human activity therefore coexists with continued exchange within the infrastructure that supports artificial provision.

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Proposition 5.10 (Exchange persistence)**.** *When productive agents retain heterogeneous holdings, requirements, or access rights over governed generative conditions, productive-carrier substitution remains compatible with continuing exchange relations among human, artificial, and institutional agents.*

Proposition 5.10 establishes the analytical bridge to the later treatment of monetary forms. If transferable claims remain useful for coordinating heterogeneous access, money-like institutions can remain intelligible after human productive labour has receded.

5.6 Power Persistence

Power provides the third persistence case and completes the section's structural test. Its role is to examine whether control over another agent's feasible generative possibilities survives productive-carrier substitution. The analysis focuses on access, authorization, maintenance, modification, and rule-setting capacities that can shape generation without requiring direct command over labour.

An artificial agent can possess extensive productive competence while depending on another actor for compute allocation, energy, model updates, network access, embodiment, continuity permissions, or legal recognition. The controlling actor can thereby influence the scale, duration, direction, or feasible domain of the artificial agent's activity. Comparable relations can operate among artificial agents when one agent or institution governs resources required by another.

Definition 5.11 (Carrier-independent generative power)**.** *Carrier-independent generative power* is the effective capacity of an agent or institution to alter another agent's feasible generative possibilities through control over access, conditions, permissions, maintenance, modification, or institutional recognition, irrespective of the productive carrier's biological or artificial form.

Definition 5.11 locates power within the governance layer of GRE. The definition includes command relations while also covering infrastructural and institutional forms of control whose effects operate through the structure of possibility itself.

The persistence of power after automation has an important implication for political-economic analysis. Removing a requirement for human labour can reduce one historically important source of dependence while leaving control over generative conditions highly asymmetric. Productive abundance and generative autonomy therefore remain analytically distinct dimensions.

Proposition 5.12 (Power persistence)**.** *Power relations remain structurally available after productive-carrier substitution when agents or institutions retain asymmetric control over the conditions required for other agents to activate, sustain, modify, or reproduce generative capacity.*

Proposition 5.12 completes the persistence test developed in this section. Resource dependence, exchange, and power can remain intelligible after extensive replacement of human productive labour because their underlying relations concern access to and governance of generative conditions. The universal-AI thought experiment therefore supports a shift in analytical emphasis from the identity of the productive carrier toward the relational organization of generative capacity. The following sections use this result to examine monetary forms, capital, exploitation, and broader multi-agent political economy.

6 Monetary Persistence

This section examines monetary forms after productive-subject substitution has been established as compatible with persistent resource dependence, exchange, and power. Its role is to determine the relational conditions under which transferable claims remain useful when artificial agents become major productive carriers. The section has six objectives. Subsection 6.1 specifies heterogeneous generative requirements; Subsection 6.2 identifies the scarcity conditions that preserve allocation problems; Subsection 6.3 develops transferable claims over generative inputs; Subsection 6.4 examines coordination across time;

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Subsection 6.5 specifies the transition toward generalized claim systems; and Subsection 6.6 identifies conditions under which monetary forms can re-emerge. The method is functional and relational. Monetary institutions are analyzed through the coordination tasks they perform within a generative system, while the biological or artificial identity of the participating agents is treated as a variable rather than a defining premise.

6.1 Requirement Heterogeneity

Heterogeneity provides the first condition for monetary persistence under agent substitution. Its analytical role is to show why extensive productive competence does not imply identical resource requirements across agents. Artificial productive agents can differ in computational architecture, embodiment, task specialization, temporal horizon, energy profile, data dependence, maintenance requirements, legal permissions, and infrastructural location. These differences create distinct patterns of demand over generative conditions.

A universal-AI limit case can substantially reduce dependence on specialized human labour while retaining heterogeneity among the artificial systems that perform production. One agent can require high-bandwidth computation, another precision fabrication, another mobility, another access to specialized datasets, and another sustained energy provision. The resulting economy can therefore contain highly capable agents whose effective generative capacities depend on different combinations of conditions.

Definition 6.1 (Heterogeneous generative requirements)**.** *Heterogeneous generative requirements* are differences across agents in the resources, permissions, infrastructures, temporal access, maintenance, and complementary capacities required to activate, sustain, or reproduce their generative capacities.

Definition 6.1 separates productive sophistication from uniformity of need. Greater artificial competence can increase the range of outputs an agent can generate while leaving the composition of required inputs differentiated across agents and tasks.

The distribution of requirements also affects the topology of exchange. Agents with complementary holdings can coordinate directly, while agents embedded in dense networks can face repeated transfers across many resource domains. A sufficiently complex pattern of heterogeneous requirements therefore creates demand for mechanisms that reduce the informational and transactional burden of matching each required input with a particular counterparty.

Proposition 6.2 (Requirement heterogeneity and coordination demand)**.** *When productive agents possess heterogeneous generative requirements and heterogeneous access to the conditions that satisfy them, coordination mechanisms that compare, transfer, and settle claims across resource domains can retain political-economic significance after productive-subject substitution.*

Proposition 6.2 establishes the first link between agent substitution and monetary persistence. Monetary coordination becomes relevant through heterogeneity in generative requirements, regardless of whether the productive agents are human, artificial, or mixed.

6.2 Input Scarcity

Scarce generative inputs provide the second condition. This subsection identifies the resource constraints that preserve allocation problems even within a highly productive artificial economy. The relevant scarcity can arise from physical limits, temporal congestion, infrastructural bottlenecks, institutional permissions, or competing claims over shared generative conditions.

Artificial abundance can lower the marginal cost of many generated outcomes while increasing demand for the infrastructures that support their production. Computation, energy, network capacity, fabrication time, land, specialized materials, environmental capacity, secure data access, and maintenance windows can remain limited relative to simultaneous demand. Scarcity can therefore migrate from final outputs toward the conditions that permit those outputs to be generated.

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Definition 6.3 (Scarce generative input)**.** A *scarce generative input* is a resource, permission, infrastructural service, temporal slot, or environmental capacity whose available supply constrains the simultaneous activation, maintenance, or reproduction of competing generative processes.

The definition includes both materially finite inputs and institutionally governed inputs. A computational service can be physically expandable while access remains constrained by ownership, authorization, safety rules, contractual priority, or network design. GRE therefore treats scarcity as a property of effective access within a generative system rather than solely as a property of physical quantity.

Scarcity also creates opportunity costs among otherwise compatible productive projects. Allocating a fabrication line, high-performance computing cluster, or energy reserve to one generative process can delay another. Such trade-offs create demand for ranking, queuing, rationing, negotiation, or exchange. Monetary forms constitute one family of coordination mechanisms among several possible institutional responses.

Remark 6.4 (Plural allocation mechanisms)**.** Scarce generative inputs can be allocated through administrative rules, queues, lotteries, priority systems, reciprocal obligations, bargaining, quotas, transferable claims, or generalized monetary systems. GRE therefore treats monetary coordination as one possible institutional response to generative scarcity rather than as an automatic consequence of scarcity itself.

Remark 6.4 preserves the institutional openness of the analysis. The subsequent subsections identify the additional conditions that make transferable and generalized claims increasingly useful.

6.3 Claim Transferability

Transferability links scarce generative inputs to monetary forms. The role of this subsection is to distinguish direct access rights from claims that can circulate among agents. A direct authorization can allow one agent to use a specific resource. A transferable claim can move across agents before final redemption, allowing allocation to respond to changing requirements, opportunities, and temporal priorities.

Consider an artificial agent that holds more computational capacity than its present task requires while another agent requires additional computation and controls fabrication time useful to the first agent. Direct barter can coordinate the two agents when their needs coincide. Larger networks with many resource domains and changing requirements create more complex matching problems. Transferable claims can reduce this matching burden by allowing an agent to accept a claim whose eventual redemption can occur through a wider network.

Definition 6.5 (Transferable generative claim)**.** A *transferable generative claim* is an institutionally recognized entitlement to obtain a specified quantity, priority, service, permission, or resource relevant to generation, where the entitlement can be reassigned among eligible agents before redemption.

Transferability changes the function of an access right. A non-transferable energy quota governs direct use by its assigned holder. A transferable energy claim can circulate and become part of a wider exchange network. The claim acquires additional coordination value because an agent can accept it even when immediate consumption is unnecessary.

Proposition 6.6 (Transferability and network reach)**.** *When claims over scarce generative inputs are transferable across eligible agents, the feasible network of exchange expands beyond contemporaneous bilateral coincidence of requirements, thereby increasing the potential coordination role of claim-based settlement.*

Proposition 6.6 identifies a mechanism through which tokenized or account-based claims can gain economic significance in artificial-agent systems. The mechanism depends on institutional acceptance and transfer rules more directly than on the physical form of the claim.

Transferability can also create secondary political-economic effects. Agents able to accumulate broadly accepted claims gain flexibility in future access, while agents receiving narrowly redeemable or weakly accepted claims remain more constrained. The architecture of claim transfer therefore enters the distribution of effective generative access developed in Subsection 4.2.

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6.4 Temporal Coordination

Intertemporal coordination introduces storage, deferred exchange, and future access into the analysis. Its role is to explain why a claim can remain valuable even when current productive needs are already satisfied. Generative processes unfold across time, and agents can face asynchronous production cycles, maintenance schedules, investment horizons, uncertain future requirements, and delayed opportunities.

An artificial agent can generate a service today while requiring additional energy, computation, embodiment, or maintenance at a later period. A claim that preserves purchasing or access capacity across this interval allows current contribution to support future generation. Intertemporal transfer thereby separates the timing of contribution from the timing of resource use.

Definition 6.7 (Intertemporal generative claim)**.** An *intertemporal generative claim* is a recognized entitlement whose validity persists across time and can be retained for future access to generated outcomes or generative conditions.

Intertemporal claims can support several functions: reserve formation, deferred settlement, maintenance planning, investment in future generative capacity, and buffering against temporary resource shocks. These functions can remain relevant even when artificial systems perform production and exchange autonomously.

The persistence of claims across time also creates institutional questions concerning depreciation, expiration, interest, priority, and enforceability. A claim that is stable across long intervals can accumulate influence over future resource allocation. An agent with a large stock of durable claims can thereby obtain expanded choice over future generative conditions.

Proposition 6.8 (Temporal separation and stored claims)**.** *When contributions, resource requirements, and generative opportunities occur at different times, durable claims can coordinate present transfers with future access and can become instruments for preserving or expanding future generative possibility.*

Proposition 6.8 links monetary persistence to the temporal structure of generation. The result remains available under human, artificial, and mixed-agent economies because the underlying coordination problem concerns asynchronous generation rather than the biological identity of the participants.

6.5 Claim Generalization

Generalization provides the transition from domain-specific tokens to monetary systems with broader reach. The role of this subsection is to specify how separate claims over computation, energy, fabrication, logistics, data, or other resources can become connected through a common settlement architecture. The analysis distinguishes specialized allocation instruments from claims accepted across multiple resource domains.

A domain-specific token can provide access to a particular service while remaining unsuitable for unrelated transactions. Such a token functions primarily as an allocation right. Broader acceptance arises when agents, infrastructures, or institutions treat a claim as redeemable, exchangeable, or convertible across multiple domains. The claim then acquires a generalized coordination function because its holder can defer the choice of the specific resource eventually obtained.

Definition 6.9 (Generalized generative claim system)**.** A *generalized generative claim system* is an institutional architecture in which recognized claims can be transferred, retained, settled, or converted across multiple categories of generated outcomes and generative conditions within a sufficiently broad network of agents.

Generalization reduces the need to maintain separate bilateral exchange relationships for each resource class. It also creates a common layer through which heterogeneous generative requirements can be compared institutionally. The resulting system can support machine-to-machine settlement while remaining largely invisible to human users whose access is mediated by autonomous agents.

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Generalization has distributional consequences. Broadly accepted claims provide greater option value than narrowly redeemable claims because they preserve choice across more future states. Institutions that determine convertibility, settlement priority, issuance, revocation, and acceptance therefore shape effective generative access through the design of the claim system itself.

Proposition 6.10 (Generalization and monetary functionality)**.** *As transferable and durable claims become accepted across a wider range of generated outcomes and generative conditions, their coordination functions increasingly include settlement, deferred access, comparison across domains, and storage of future generative option value.*

Proposition 6.10 identifies a continuum between specialized allocation tokens and more generalized monetary forms. The analytical boundary depends on institutional function and network scope rather than terminology alone.

6.6 Monetary Emergence

Monetary re-emergence completes the section's structural argument. Its role is to specify the conditions under which monetary coordination can arise again after extensive productive-subject substitution. The universal-AI thought experiment removes a major historical source of exchange dependence while preserving the possibility of heterogeneous requirements, scarce inputs, transferable claims, temporal separation, and generalized settlement.

Definition 6.11 (Monetary re-emergence)**.** *Monetary re-emergence* is the formation or renewed expansion of generalized transferable claim systems when agents require a common mechanism for coordinating access to heterogeneous and temporally distributed generated outcomes or generative conditions.

The definition treats money as an institutional manifestation of a deeper relational problem. A monetary form can disappear from direct human experience while generalized claims continue to circulate among artificial agents and infrastructures. Conversely, a society can abolish a particular currency while preserving relations that motivate new generalized claims. The persistence test therefore concerns the generative conditions of monetary coordination rather than the survival of any specific monetary instrument.

Proposition 6.12 (Carrier independence of monetary possibility)**.** *Monetary forms remain structurally possible after productive-subject substitution when heterogeneous agents coordinate scarce or governed generative inputs through transferable, durable, and sufficiently generalized claims.*

Proposition 6.12 supplies a central result of the universal-AI stress test. Extensive automation can reduce labour-mediated exchange while leaving the relational conditions for generalized claim systems available. The analytical focus therefore shifts from the identity of the labouring subject toward the organization of access, scarcity, transferability, temporal coordination, and institutional acceptance.

Corollary 6.13 (Manifestational replacement)**.** *The disappearance of a specific currency, token, or human-facing payment practice can coexist with continuing monetary functionality when generalized transferable claims remain embedded in the coordination of generative conditions.*

Corollary 6.13 clarifies the relevance of agent substitution for GRE. Economic forms can change at the manifestational level while the generative relations supporting them persist. The following section extends this result to capital and generative control by examining how claims over future generativity can become recursively accumulated and institutionally concentrated.

7 Capital Dynamics

This section extends the structural persistence analysis from monetary coordination to capital accumulation. Its role is to identify the relations through which transferable claims, productive assets, and

infrastructural authority can become durable control over future generation after productive-subject substitution. The section has five objectives. Subsection 7.1 specifies claims on future generativity; Subsection 7.2 examines control over the infrastructures that enable recurrent production; Subsection 7.3 develops recursive accumulation; Subsection 7.4 distinguishes expansion in generative control from one-period surplus; and Subsection 7.5 analyzes capital-like circuits that can be executed by artificial agents. The discussion uses a relational and recursive method. Capital is examined through the conversion of present claims and control into enlarged future access to generative conditions, while the identity of the productive carrier remains analytically variable.

7.1 Future Claims

Claims on future generativity provide the first bridge between monetary coordination and capital-like organization. Their analytical role is to distinguish a claim that facilitates current exchange from a claim whose institutional structure reaches into future production. A transferable resource claim can settle a present transaction, while a durable claim can also reserve future output, future resource access, or future use of generative capacity.

The distinction becomes especially important under universal artificial generativity. An artificial agent can generate large volumes of output while depending on future compute allocations, energy contracts, model access, embodiment, maintenance, or network permissions. An actor that secures durable claims over those conditions can obtain a position that affects generation beyond the current exchange period. The relevant object is therefore the temporal extension of control over generative possibility.

Definition 7.1 (Claim on future generativity)**.** A *claim on future generativity* is an institutionally supported entitlement that grants an agent prospective access to generated outputs, generative capacity, or generative conditions across a future interval.

Definition 7.1 covers heterogeneous institutional forms. A claim can concern a future flow of outputs, reserved computational capacity, priority access to energy, a licence to use a model, a contractual right to machine time, or a residual claim linked to an organization that controls productive infrastructure. The common analytical feature is prospective access to future generation.

The political-economic significance of such claims depends on durability, enforceability, transferability, exclusivity, and scope. A short-lived right to use a resource for one task has limited temporal reach. A renewable or inheritable claim can shape a much longer generative trajectory. A broadly enforceable claim can also become valuable beyond the original production context because other agents recognize its capacity to organize future access.

Proposition 7.2 (Temporal extension of generative claims)**.** *When transferable claims become durable entitlements over future outputs, capacities, or enabling conditions, monetary coordination can support persistent control over future generative opportunities.*

Proposition 7.2 identifies a transition in temporal structure. The analytical focus moves from coordination among present claims to the institutional organization of future generativity. This temporal extension supplies one condition for capital accumulation under both human and artificial productive agency.

7.2 Infrastructure Control

Generative infrastructure provides the second element of capital-like organization. Its structural role is to identify the durable conditions through which many productive acts become possible. Computation, energy systems, robotic fleets, fabrication facilities, logistical networks, data infrastructures, land, and institutional permissions can each support repeated generation across multiple agents and periods.

Control over such infrastructure can take several forms. An actor can hold legal title, possess operational authority, administer access credentials, set allocation priorities, maintain technical dependencies,

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or control the interfaces through which other agents reach the infrastructure. These forms can overlap while remaining analytically distinct. Effective control therefore depends on the ability to shape access and use, not solely on nominal ownership.

Definition 7.3 (Generative infrastructure control)**.** *Generative infrastructure control* is the durable capacity of an agent or institution to authorize, allocate, constrain, maintain, modify, or withdraw access to infrastructure that enables recurrent generation by multiple agents.

Definition 7.3 locates infrastructure control within the generative-governance layer developed in Section 4. The definition also clarifies why technically abundant productive competence can coexist with concentrated political-economic power. A highly capable artificial agent can perform many tasks while remaining dependent on a small number of infrastructural gateways.

Infrastructure control can produce recurrent claims on generated outcomes without direct participation in each productive act. An actor that governs compute, energy, fabrication, or platform access can condition the terms under which other agents activate their capacities. This relation can support recurring transfers of claims, fees, output shares, priority rights, or other forms of appropriation.

Proposition 7.4 (Infrastructure leverage)**.** *When many agents depend on a shared generative infrastructure, durable control over that infrastructure can convert localized control into recurrent influence over a wider field of generative activity.*

Proposition 7.4 links concentration to network position. The extent of leverage depends on substitutability, entry conditions, interoperability, redundancy, and the availability of alternative infrastructures. Generative control therefore varies with the relational organization surrounding the asset rather than with the asset in isolation.

7.3 Accumulation Recursion

Recursive accumulation supplies the dynamic mechanism of this section. Its role is to explain how present access or surplus can alter the conditions of future generation and thereby affect subsequent accumulation. The mechanism requires a feedback relation linking current control, generated surplus, reinvestment, and enlarged future capacity or governance.

A one-period surplus can be consumed, distributed, stored, or reinvested. Reinvestment becomes structurally significant when it purchases, expands, or secures conditions that increase future generative access. An agent can use current claims to obtain additional compute, more capable models, robotic bodies, energy capacity, data, land, network priority, or rights over organizations that govern these resources. These acquisitions can increase future output and can also strengthen the agent's position in allocation and governance.

Definition 7.5 (Recursive generative accumulation)**.** *Recursive generative accumulation* is a process in which claims or control obtained during one period are reinvested into generative capacity or generative conditions in ways that expand the agent's prospective ability to obtain further claims or control.

Definition 7.5 distinguishes accumulation from simple retention. The defining feature is feedback into future generativity. The process can operate through productive expansion, infrastructural acquisition, contractual priority, institutional influence, model improvement, or combinations of these mechanisms.

Recursive accumulation can also operate across organizational boundaries. An artificial agent can reinvest through delegated transactions; a human owner can authorize an agent to expand an asset portfolio; an institution can deploy autonomous systems to allocate surplus; or several artificial agents can coordinate investments through machine-mediated agreements. The recursive structure therefore remains available across different distributions of human and artificial agency.

Proposition 7.6 (Recursive amplification)**.** *When current claims can be converted into conditions that increase future generative access or governance capacity, accumulation can become self-reinforcing across successive periods.*

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Proposition 7.6 identifies a mechanism of dynamic asymmetry. Initial differences in claims or infrastructure can influence later differences when reinvestment changes the conditions under which future generation occurs. The magnitude and persistence of this amplification remain contingent on institutional rules, technological substitutability, competition, public provision, collective governance, and countervailing access arrangements.

7.4 Control Expansion

Expansion of generative control provides a broader measure of accumulation than output growth alone. Its analytical role is to track changes in the scope, depth, duration, and reproducibility of an agent's influence over future generation. This distinction matters because increased production and increased control can move together, diverge, or become institutionally separated.

The scope of control concerns the range of agents, resources, or domains affected. Depth concerns the degree to which access and activity depend on the controlling actor. Duration concerns the temporal persistence of that control. Reproducibility concerns the capacity to renew or extend control through subsequent rounds of generation and accumulation. These dimensions permit comparison among forms of control that would appear similar if measured only through current output or stored wealth.

Definition 7.7 (Expansion of generative control)**.** *Expansion of generative control* is an increase in the effective scope, depth, duration, or reproducibility of an agent's capacity to shape access to generative capacities or the conditions under which future generation occurs.

Definition 7.7 places capital accumulation within the broader GRE architecture. A rise in monetary holdings can support expansion when those holdings secure future capacity or governance. An increase in productive assets can support expansion when other agents depend on them. A change in protocol, licence, or institutional authority can also expand control even when the stock of physical assets remains unchanged.

The distinction also helps identify concentration processes under artificial agency. A highly capable artificial agent can use accumulated claims to secure infrastructures that support its own operation and the operation of dependent agents. A platform or institution can similarly expand control by integrating compute, data, embodiment, logistics, and settlement functions into one access architecture. These configurations can increase the number of productive functions coordinated through a narrower set of governance points.

Proposition 7.8 (Control concentration)**.** *When recursive accumulation systematically increases the scope, depth, duration, or reproducibility of control over generative conditions, productive expansion can be accompanied by concentration of generative governance.*

Proposition 7.8 specifies a structural possibility rather than a deterministic trajectory. Decentralized infrastructures, interoperability, collective ownership, regulatory constraints, public provisioning, and distributed technical architectures can alter the feedback process. GRE therefore treats concentration as an emergent relational outcome whose mechanisms require empirical specification.

7.5 Agent Capital Circuit

Artificial-agent capital circuits complete the section by examining accumulation when artificial agents execute substantial portions of acquisition, production, exchange, and reinvestment. The subsection's role is to separate the operational autonomy of an accumulating system from the legal and normative status of the artificial agents participating in it. The analysis therefore focuses on circuit structure, attribution, and control.

An artificial agent can receive claims, purchase inputs, allocate compute, contract for energy, schedule robotic production, sell generated outputs, retain a balance, and reinvest that balance in expanded

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capacity. A network of agents can distribute these functions across specialized systems while coordinating them through machine-readable contracts or tokenized settlement. Human actors can remain owners, beneficiaries, rule setters, or supervisors even when routine accumulation is executed autonomously.

Definition 7.9 (Artificial-agent capital circuit)**.** An *artificial-agent capital circuit* is a recurrent process in which artificial agents execute a substantial sequence of resource acquisition, production, claim realization, and reinvestment that expands future generative capacity or control.

Definition 7.9 does not assign legal ownership, moral personhood, or ultimate beneficiary status to the artificial agent. Those questions concern attribution and rights. The circuit definition identifies operational structure: accumulation can proceed through artificial agency even when legal title or residual benefit remains assigned elsewhere.

This distinction has a foundational consequence for the universal-AI thought experiment. Capital-like accumulation does not depend analytically on the simultaneous presence of a human capitalist and a human labourer. The relevant structure can persist when artificial systems occupy productive and coordinative positions, provided that claims over future generativity, control over enabling conditions, and recursive reinvestment remain institutionally available.

Proposition 7.10 (Carrier independence of capital-like circuits)**.** *A capital-like accumulation circuit can remain structurally intelligible after productive-subject substitution when agents can secure prospective claims, control generative conditions, realize surplus claims, and reinvest them into expanded future generativity or governance.*

Proposition 7.10 extends the persistence test beyond exchange and money. The productive carrier can change while recursive accumulation remains available through the relational organization of claims and generative conditions. This result prepares the subsequent analysis of generativity exploitation, where the distributional and power consequences of such accumulation become the central object of inquiry.

8 Exploitation Structure

This section develops the exploitation component of the Generative Relational Economics framework. Its role is to identify forms of asymmetric appropriation that remain analytically available after productive-subject substitution and after the expansion of artificial productive agency developed in Sections 5–7. The section has six objectives. Subsection 8.1 examines appropriation at the level of generated outcomes; Subsection 8.2 extends the analysis to the directed use of generative capacity; Subsection 8.3 locates exploitation within dependence on enabling conditions; Subsection 8.4 analyzes unequal influence over the feasible space of future generation; Subsection 8.5 develops the feedback mechanisms through which asymmetry can reproduce itself; and Subsection 8.6 generalizes the framework across human, artificial, and mixed-agent relations. The discussion uses a layered and recursive method. Exploitation is examined across outcomes, capacities, and generative conditions, with particular attention to how advantages at one layer can be converted into durable control at another.

The term *exploitation* carries substantial normative and theoretical commitments in different traditions. The present section therefore begins with a structural use of the concept and keeps stronger normative judgments available for later specification. The structural question concerns whether one agent or institutional arrangement can systematically obtain benefits from another agent's generative contribution through relations that constrain access, direct capacity, or shape future conditions. This formulation allows GRE to compare familiar labour relations with artificial-agent and mixed-agent settings while preserving variation in the normative status of asymmetric transfers.

Definition 8.1 (Generativity exploitation)**.** *Generativity exploitation* is a recurrent relational structure in which an agent or institutional arrangement secures benefits from another agent's generative contribution through asymmetric control over generated outcomes, generative capacities, or the conditions that govern future generation.

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Definition 8.1 provides a general analytical category. Its application requires specification of the relevant benefit, contribution, dependency, and control relation. The category therefore supports comparison across heterogeneous economies while leaving the normative threshold for objection to be argued in context.

8.1 Outcome Appropriation

Output appropriation provides the most immediate layer of the exploitation analysis. Its role is to identify relations in which generated outcomes are transferred, assigned, or captured through an institutional structure that distributes the benefits of generation asymmetrically. The relevant output can include goods, services, information, monetary claims, intellectual products, data, or other results that acquire economic significance within a generative system.

The three-layer architecture developed in Section 4 makes output appropriation analytically distinct from control over the underlying capacity that produced the output. An agent can retain substantial control over its activity while surrendering part of the resulting product. A different arrangement can transfer both the product and the conditions of subsequent production. GRE therefore treats output-level appropriation as one possible manifestation of a broader generative relation.

Definition 8.2 (Output appropriation)**.** *Output appropriation* is an institutionalized transfer or assignment through which an agent or organization acquires a share of generated outcomes produced through the generative activity of another agent or coordinated system.

Output appropriation can arise through ownership rules, contracts, platform fees, licensing arrangements, revenue-sharing structures, debt claims, access charges, or governance rules assigning generated products to a controlling entity. The normative status of a transfer remains contingent on reciprocity, consent, background dependency, bargaining conditions, risk allocation, and the reproduction of future capacities.

The universal-AI thought experiment makes this distinction especially useful. An artificial agent can produce an output while legal ownership, residual claims, or settlement rights remain assigned to a human owner, platform, institution, or another artificial agent. The productive carrier and the beneficiary can therefore diverge. This divergence shows that the distribution of output can be analyzed independently from the biological or artificial identity of the productive agent.

Proposition 8.3 (Carrier independence of output appropriation)**.** *When institutional rules assign generated outcomes to agents other than the productive carrier, asymmetric output appropriation can remain structurally available across human, artificial, and mixed-agent production systems.*

Proposition 8.3 extends the structural persistence test to distribution. Automation can alter who performs productive activity while leaving the allocation of resulting claims governed by separate ownership, contractual, or institutional arrangements. The exploitation analysis therefore places primary attention on the relation between contribution and appropriation, while treating productive identity as a separate analytical dimension.

Output appropriation also provides an entry point to recursive analysis. An appropriated outcome can be consumed, redistributed, stored, or reinvested. When it is converted into expanded future control over generative conditions, an output-level asymmetry can become a capacity-level or governance-level asymmetry. The following subsection develops this deeper form.

8.2 Capacity Appropriation

Capacity appropriation shifts the analytical focus from generated results to the direction and use of generative capability itself. Its role is to examine relations in which one agent obtains recurrent benefit from another agent's capacity to generate, coordinate, create, maintain, or transform resources. The category therefore concerns the organization of generativity before a specific output has been realized.

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A generative capacity can include human labour, expertise, organizational competence, computational intelligence, robotic embodiment, model capability, scientific instrumentation, or coordinated access to several such resources. Capacity becomes subject to appropriation when another agent can direct, reserve, schedule, or condition its use in ways that channel a substantial portion of its generative potential toward external objectives.

Definition 8.4 (Capacity appropriation)**.** *Capacity appropriation* is a recurrent arrangement in which an agent or institution acquires effective direction over another agent's generative capacity and uses that direction to secure outcomes, claims, or future advantages.

Definition 8.4 makes direction central. The relevant relation can arise through employment, contractual delegation, ownership, platform dependence, technical permissions, scheduling authority, or control over the resources required for activation. The degree of appropriation varies with the breadth of tasks covered, the duration of control, the availability of exit, and the extent to which the generative agent can redirect its own capacity.

Artificial agency expands the range of possible arrangements. A human can own or operate an artificial agent whose generative capacity is deployed for external objectives. An artificial agent can also acquire services from another artificial agent through machine-mediated contracts. A platform can coordinate a population of specialized agents and determine the tasks, resource limits, and settlement conditions under which their capabilities are activated. These configurations differ in legal and moral status while sharing a common structural feature: control over capacity can be separated from the immediate bearer of that capacity.

Proposition 8.5 (Direction and appropriation)**.** *The greater an actor's durable ability to direct another agent's generative capacity while retaining claims over the resulting benefits, the stronger the structural basis for capacity-level appropriation.*

Proposition 8.5 identifies a graded relation whose intensity varies across institutional arrangements. Durable control can remain limited by exit rights, alternative infrastructures, contractual safeguards, collective governance, technical interoperability, or competing access channels. GRE therefore treats capacity appropriation as relationally variable and institutionally mediated.

The distinction between output and capacity appropriation also clarifies why automation alone leaves the exploitation problem analytically open. Replacing a human productive carrier with an artificial productive carrier can reduce human exposure to certain forms of directed labour while preserving the institutional ability to appropriate artificial generativity. The distributional consequence for humans then depends on ownership, beneficiary status, access, and governance. The locus of appropriation can move while the underlying structure of directional control remains available.

8.3 Condition Dependency

Dependency on generative conditions provides the infrastructural layer of exploitation analysis. Its role is to identify how control over enabling conditions can create recurrent claims on agents whose generative capacities depend on those conditions. This layer is central to GRE because effective capacity requires access to resources, permissions, infrastructures, and institutional environments that lie partly outside the immediate agent.

Section 3 defined generative conditions broadly enough to include material resources, infrastructures, permissions, protocols, legal arrangements, organizational access, and relational environments. An agent can possess substantial intrinsic capability while remaining dependent on external compute, energy, data, embodiment, land, logistics, finance, or network access. Control over these conditions can therefore become a basis for recurring extraction or directional influence.

Definition 8.6 (Generative-condition dependency)**.** *Generative-condition dependency* is a relation in which an agent's effective capacity to generate relies on access to enabling conditions governed partly by another agent or institution.

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The exploitation relevance of dependency depends on the surrounding institutional structure. A shared infrastructure can support broad capability when access is secure, transparent, and collectively governed. The same technical infrastructure can support asymmetry when access is revocable, discriminatory, highly concentrated, or conditioned on transfers that expand the controller's future power. The object of analysis is therefore the institutional governance and organization of dependency.

An artificial-agent economy makes these relations especially visible. Autonomous agents can require continuous energy, computation, maintenance, network connectivity, hardware replacement, model updates, and authorization. A controller of these conditions can influence which agents remain active, which capacities expand, and which transactions are feasible. Operational autonomy can therefore coexist with infrastructural dependence.

Proposition 8.7 (Conditioned generativity)**.** *When effective generative capacity depends on scarce or governed conditions, durable control over those conditions can support recurrent claims on the agents whose generation they enable.*

Proposition 8.7 links generative-condition governance to appropriation. Access fees, resource payments, and infrastructural charges occupy normatively heterogeneous positions. The proposition identifies a structural pathway through which control over enabling conditions can be converted into recurring economic advantage. Normative evaluation requires further attention to reciprocity, institutional alternatives, distribution of risk, cost recovery, collective benefit, and the reproduction of shared capacity.

Generative-condition dependency also connects exploitation to capital accumulation. When appropriated claims are reinvested into additional control over the same conditions, dependency can become self-reinforcing. This mechanism prepares the analysis of asymmetric generative possibility.

8.4 Possibility Asymmetry

Asymmetric generative possibility extends exploitation analysis beyond current transfers and current capacity use. Its role is to examine differences in the feasible set of future generative actions available to agents because of unequal access, permissions, resources, or governance influence. This level matters because exploitation can alter future possibilities even when current outputs appear adequate.

An agent's generative possibility depends on the range of projects, relations, resource combinations, and developmental trajectories that remain feasible under prevailing conditions. Access to compute can expand the feasible scale of artificial research; access to education and institutions can expand human capability; permission to modify a model can expand future artificial agency; and participation in rule formation can expand an agent's ability to influence subsequent conditions. These possibilities are relational because they depend on structures extending beyond the isolated agent.

Definition 8.8 (Generative possibility)**.** An agent's *generative possibility* is the institutionally and materially feasible set of future generative actions, projects, relations, and developmental trajectories available under prevailing generative conditions.

Definition 8.9 (Asymmetric generative possibility)**.** *Asymmetric generative possibility* is a relational condition in which agents with relevant generative capacities face systematically different feasible sets because access to enabling conditions, permissions, or governance influence is unequally structured.

This formulation widens the temporal horizon of exploitation. An arrangement can distribute current output while still narrowing one agent's future choices. A contract can provide present resources while transferring long-duration control over data, infrastructure, intellectual products, or modification rights. A platform can increase immediate productive opportunity while concentrating rule-setting authority. GRE therefore analyzes both current benefits and changes in prospective generative space.

Proposition 8.10 (Possibility-space effect)**.** *Control over generative conditions can produce exploitation-relevant asymmetry when it systematically expands one actor's future generative possibility while constraining the feasible trajectories available to dependent agents.*

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The distinction is formalized in Proposition 8.10. Power concerns the capacity to shape another agent's generative possibility. Exploitation concerns the use of asymmetric relations to secure recurrent benefit from generative contribution. Power can occur independently of recurrent appropriation, while exploitation can intensify when power over future possibility supports recurring extraction.

Artificial-agent systems again broaden the domain of application. An agent permitted to update itself, acquire resources, create subagents, or migrate across infrastructures can possess a wider future possibility set than an equally capable agent whose permissions are fixed by an external controller. Similar asymmetries can occur among human actors, institutions, and mixed human-AI organizations. The substrate changes while the analytical role of structured possibility remains available.

8.5 Asymmetry Reproduction

Recursive reproduction of asymmetry supplies the dynamic mechanism linking exploitation to long-run political-economic structure. Its role is to show how appropriation can alter future generative conditions and thereby reproduce or amplify the relation that enabled appropriation in the first place. The mechanism extends the recursive accumulation analysis of Subsection 7.3 by tracing consequences across differently positioned agents.

A controller can appropriate a share of output or direct a dependent capacity, convert the resulting claims into infrastructure, permissions, data, organizational reach, or governance influence, and thereby strengthen its position in the next period. The dependent agent can simultaneously experience reduced access to the resources required for independent expansion. Repetition can therefore create cumulative divergence even when each individual transaction appears locally intelligible.

Definition 8.11 (Recursive reproduction of generative asymmetry)**.** *Recursive reproduction of generative asymmetry* is a process in which unequal appropriation or control in one period modifies future generative conditions in ways that preserve or enlarge the asymmetry between participating agents.

The mechanism can operate through several channels. Resource accumulation can purchase additional productive infrastructure. Data accumulation can improve future model performance. Network accumulation can strengthen access to counterparties. Institutional influence can shape standards or permissions. Reputation and recognition can alter future access. These channels can interact and create multi-layer feedback across outcomes, capacities, and generative conditions.

Proposition 8.12 (Asymmetry feedback)**.** *When appropriated benefits can be converted into stronger control over future generative conditions, exploitation can contribute to a self-reinforcing feedback process that reproduces or expands the original asymmetry.*

Proposition 8.12 identifies a contingent mechanism whose operation varies across institutional environments. Redistribution, collective governance, public infrastructure, interoperability, rights to exit, countervailing institutions, and technical decentralization can interrupt or reverse the feedback. GRE therefore treats recursive asymmetry as contingent on institutional reproduction and open to empirical comparison.

This recursive view also clarifies the distinction between a one-time unequal transfer and a structurally significant exploitative relation. A transient transfer can end with the transaction. A recursive relation changes the conditions of subsequent transactions and can reshape the range of alternatives available to the parties. The temporal reproduction of asymmetry therefore deserves separate attention in both positive and normative analysis.

8.6 Cross-Agent Exploitation

Cross-agent exploitation structures complete the section by generalizing the framework across heterogeneous economic agents. The subsection's role is to test whether output appropriation, capacity appropriation, generative-condition dependency, asymmetric possibility, and recursive asymmetry remain

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intelligible when the parties include humans, artificial agents, institutions, and mixed human-AI organizations. The analysis treats agent type and relational position as distinct dimensions.

Four broad configurations can be distinguished: human–human, human–artificial, artificial–human, and artificial–artificial relations. Human–human cases include familiar relations of employment, contracting, platform dependence, and infrastructural control. Human–artificial cases arise when humans or institutions own, direct, restrict, or appropriate outputs from artificial agents. Artificial–human cases can arise when automated systems allocate resources, impose access conditions, or exercise delegated control over human generative possibilities. Artificial–artificial cases become relevant when agents transact, contract, allocate resources, or control infrastructures used by other agents.

Definition 8.13 (Cross-agent exploitation structure)**.** A *cross-agent exploitation structure* is a recurrent relation of asymmetric appropriation or generative control whose structural form can be instantiated across more than one configuration of human, artificial, institutional, or mixed agents.

Definition 8.13 separates structural description from moral equivalence. A human worker, a corporation, and an artificial agent can occupy analogous economic positions while possessing very different legal status, vulnerability, consciousness, welfare interests, and normative claims. GRE can therefore compare the organization of access and control while preserving the need for agent-specific ethical and legal analysis.

Proposition 8.14 (Relational persistence of exploitation structures)**.** *Exploitation-relevant structures can persist across productive-subject substitution when asymmetric appropriation, dependence on generative conditions, and recursive control remain institutionally available across changing configurations of agents.*

Proposition 8.14 supplies the central result of this section. Extensive automation can alter the bearer of productive capacity while leaving the relations through which generativity is directed, appropriated, and recursively governed structurally available. The persistence of exploitation therefore depends less on the biological identity of the productive carrier than on the organization of generative relations surrounding access, control, and reproduction.

The result also prepares the analysis of power in the following section. Generativity exploitation concerns recurrent benefit derived through asymmetric relations; power concerns the capacity to shape another agent's access, possibilities, and conditions of generation. Their overlap becomes especially important when control over generative conditions allows appropriation to reproduce itself across time. GRE therefore treats exploitation and power as distinct but interacting structures within a wider generative-relational political economy.

9 Generative Power

This section develops the power component of Generative Relational Economics. Its role is to specify how asymmetries become politically significant when one agent or institutional arrangement can alter another agent's access to generative resources, feasible courses of action, or future conditions of generation. The section has five objectives. Subsection 9.1 establishes command as a direct and visible form of generative power; Subsection 9.2 examines authority over entry to capacities and infrastructures; Subsection 9.3 analyzes power exercised through the quantity, timing, and composition of available inputs; Subsection 9.4 develops the broader category of intervention in an agent's feasible space of generation; and Subsection 9.5 examines power over the historical development of generative conditions themselves. The discussion uses a layered and relational method. Each form of power is located across generated outcomes, generative capacities, and generative conditions, and each is evaluated by its capacity to alter the future generative possibilities available to affected agents.

GRE treats power as a relation among agents and conditions of generation. The relevant relation can be exercised through explicit instruction, ownership, technical permissions, infrastructural design, contractual authority, scheduling, standards, resource allocation, or institutional rule formation. These

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mechanisms differ in visibility and legal form while sharing a common analytical feature: they influence the possibilities through which another agent can generate, sustain, redirect, or reproduce activity.

Definition 9.1 (Generative power)**.** *Generative power* is the effective capacity of an agent or institutional arrangement to alter another agent's feasible access to generative capacities, feasible courses of generation, or conditions governing future generation.

Definition 9.1 places feasible possibility at the centre of the analysis. The definition covers direct command and less visible forms of infrastructural or institutional influence. It also allows power to be distributed across several actors whose combined decisions shape a generative environment without requiring a single centralized controller.

Proposition 9.2 (Layered expression of generative power)**.** *Generative power can be expressed through outcome allocation, capacity access, or governance of generative conditions, and durable power commonly depends on conversion among these layers.*

Proposition 9.2 links the analysis of power to the three-layer architecture developed in Section 4. Control over outcomes can finance access to capacities; capacity access can support greater infrastructural control; infrastructural control can shape the future distribution of outcomes. Power therefore acquires durability through recursive inter-layer conversion.

9.1 Command Mechanism

Command relations provide the most explicit form of generative power. Their role in this section is to establish a baseline against which more indirect mechanisms can be compared. A command relation exists when one agent possesses recognized or effective authority to specify another agent's tasks, sequence of activity, operational limits, or permissible responses within a defined domain.

Command can be implemented through legal hierarchy, organizational authority, ownership, software permissions, contractual delegation, or technical control. Human employment relations provide a familiar instance, while artificial-agent systems expand the range of possible command architectures. A human operator can direct an artificial agent, an artificial coordinator can assign tasks to specialized agents, and an institutional platform can impose operational constraints across both human and artificial participants.

Definition 9.3 (Generative command relation)**.** A *generative command relation* is a recurrent arrangement in which one agent or institution possesses effective authority to specify or constrain the generative activity of another agent within a defined domain.

The generative significance of command depends on scope, duration, reversibility, and available exit. A narrow instruction concerning one task can have limited implications for the agent's wider trajectory. A durable command relation covering task selection, resource access, modification rights, and future deployment can shape a much larger portion of the agent's generative possibilities.

Artificial agency makes this distinction especially important. An artificial agent can execute tasks autonomously at the operational level while remaining subject to higher-level command through permissions, objectives, resource ceilings, or update authority. Operational autonomy therefore describes the mode of task execution, whereas generative command concerns the authority that defines the space within which such execution occurs.

Proposition 9.4 (Scope of command and generative effect)**.** *The generative effect of a command relation increases with the breadth, duration, and irreversibility of the authority exercised over task selection, resource access, and future deployment.*

Proposition 9.4 provides a graded account of command. It avoids treating every instruction as equally consequential and directs attention toward the relation between local operational control and long-run generative possibility.

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9.2 Access Mechanism

Access control extends the analysis beyond explicit command. Its role is to examine power exercised through authority over entry to generative capacities, infrastructures, networks, data, energy, computational resources, legal permissions, or institutional venues. An agent can retain broad discretion over its internal choices while remaining highly dependent on another actor for the resources that make those choices effective.

The generative access layer developed in Section 4 provides the analytical location for this mechanism. Access control concerns the rules and technical arrangements that determine whether a nominally available capacity can be activated by a particular agent under particular conditions. Eligibility criteria, subscription status, ownership rules, authentication systems, licensing arrangements, platform permissions, and priority schedules can all operate as access mechanisms.

Definition 9.5 (Generative access control)**.** *Generative access control* is the effective authority to grant, condition, prioritize, suspend, or withdraw another agent's access to a capacity or resource required for generation.

Access control can produce power even when the controller gives few direct instructions. A model provider can determine which capabilities are available to downstream agents; an energy provider can set connection conditions; a research institution can govern access to specialized equipment; a platform can determine whether an agent may enter a market or communicate with counterparties. These mechanisms shape the feasible field of action through permission and conditional entry, with limited need for continuous direction.

The importance of access control increases when substitutes are limited. Interoperability, portability, alternative infrastructures, and credible exit can reduce dependence on a single gatekeeper. Concentrated access points can produce the opposite effect by making a wide range of generative activities contingent on a small number of institutional permissions.

Proposition 9.6 (Gatekeeping and generative dependence)**.** *The power associated with access control increases when access is necessary for valued generation, alternative access channels are limited, and the controlling actor can alter permissions with durable effect.*

Proposition 9.6 connects access power with dependence. It also clarifies why technical abundance can coexist with strong political-economic asymmetry: a highly capable infrastructure can remain institutionally scarce when access is concentrated or conditional.

9.3 Resource Mechanism

Resource constraint identifies power exercised through the quantity, timing, quality, or composition of inputs available to an agent. Its role is to distinguish permission to participate from the practical ability to sustain meaningful generation after permission has been granted. An agent can possess formal access to a generative system while operating under resource limits that materially narrow its feasible activities.

Relevant constraints include computational quotas, energy budgets, bandwidth, storage, material inputs, working capital, physical space, maintenance windows, model context, data access, and time-sensitive priority. Their political-economic significance depends on how they interact with the demands of the activity under consideration. Equal nominal allocations can produce unequal effective capacities when agents face different technical requirements or inherited conditions.

Definition 9.7 (Generative resource constraint)**.** A *generative resource constraint* is an institutionally or technically imposed limitation on the quantity, timing, quality, or composition of inputs available for an agent's generative activity.

Resource constraint can operate independently from direct command and formal exclusion. A system may allow every agent to submit a task while assigning sharply different compute budgets, response

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priorities, experiment time, or energy allowances. The resulting differences can alter which projects remain feasible, which forms of experimentation can be repeated, and which agents can sustain long-duration trajectories.

Resource constraints also have cumulative effects. Repeated under-allocation can reduce maintenance, experimentation, learning, and future bargaining capacity. Preferential allocation can support expansion, redundancy, and greater resilience. The resource layer can therefore become a channel through which present asymmetry alters future generative capacity.

Proposition 9.8 (Constraint accumulation)**.** *Repeated differences in access to generative resources can accumulate into durable differences in future generative capacity when present resources affect maintenance, learning, expansion, or reproduction.*

Proposition 9.8 links resource allocation to the recursive analysis developed in Sections 3 and 4. Resource governance therefore concerns both present activity and the reproduction of future possibility.

9.4 Possibility Shaping

Generative-space modification provides the broadest analytic category within the section. Its role is to capture forms of power that alter the set of feasible generative trajectories available to an agent, including mechanisms whose effects arise through combinations of command, access, resource constraints, standards, incentives, and institutional design. The concept directs analysis toward the shape of the agent's possibility field across multiple observable transactions and institutional mechanisms.

An agent's generative space includes the activities it can practically initiate, sustain, redirect, combine, and reproduce under prevailing conditions. This space is conditioned by technical capabilities, institutional permissions, available resources, recognized rights, network position, contractual obligations, and the expected responses of other agents. Changes to any of these elements can expand, contract, redirect, or stratify the feasible set.

Definition 9.9 (Generative space)**.** An agent's *generative space* is the structured set of generative trajectories that remain practically feasible to that agent under prevailing capacities, resources, permissions, institutions, and relational conditions.

Definition 9.10 (Generative-space modification)**.** *Generative-space modification* is an intervention or institutional process that changes the structure, reach, relative cost, or accessibility of trajectories within an agent's generative space.

Generative-space modification can occur through restrictive or enabling mechanisms. An interoperability standard can expand feasible combinations across systems. A licensing rule can narrow available deployment pathways. A new public infrastructure can reduce the cost of previously inaccessible activities. A proprietary interface can concentrate dependency around a single provider. GRE therefore uses the category to describe structural effects before assigning their normative status.

The concept also helps analyze power without requiring continuous intention. A rule or infrastructure can reshape generative spaces after its original designers have left the system, and several institutions can jointly produce a patterned possibility structure without a unified directing actor. This feature is especially relevant to complex economies in which power is distributed across technical, legal, organizational, and financial arrangements.

Proposition 9.11 (Power through possibility structure)**.** *An actor or institutional arrangement exercises generative power when its decisions or durable structures materially alter the feasible trajectories available to other agents, even when direct command remains limited.*

Proposition 9.11 generalizes the section's account of power. The analytical object becomes the transformation of possibility structure, while command, access, and resource constraint appear as specific mechanisms through which such transformation can occur.

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9.5 Condition Formation

The evolution of generative conditions places power within historical reproduction. Its role is to examine influence over the processes through which future infrastructures, permissions, standards, rights, resource distributions, and institutional capacities are formed. This level is especially important for GRE because generative conditions shape subsequent access and outcomes while being continually transformed by present decisions.

Control over the evolution of generative conditions can include authority over investment, model development, standards, infrastructure expansion, legal classification, resource replenishment, research priorities, environmental use, and the reproduction of organizational capacity. Such authority extends beyond current allocation because it influences the architecture within which future agents will act.

Definition 9.12 (Generative-condition formation power)**.** *Generative-condition formation power* is the effective capacity to influence the creation, modification, persistence, or reproduction of the conditions that structure future generative possibilities.

This form of power creates a strong connection between present accumulation and future governance. Resources accumulated in one period can finance infrastructure, acquire permissions, shape technical standards, support lobbying, determine research agendas, or establish platforms that become future access points. Once embedded, these conditions can alter the bargaining positions and generative spaces of later participants.

Artificial-agent economies can intensify this recursive mechanism. An artificial agent or coordinating system that earns claims, reinvests them, expands infrastructure, and participates in rule-setting can contribute to the formation of the conditions under which subsequent agents operate. Human institutions can retain higher-level authority over these processes, share it with automated systems, or delegate substantial portions of it. GRE treats the resulting configuration as an empirical and institutional question whose locus of control must be identified from the actual governance arrangement.

Proposition 9.13 (Historical reproduction of generative power)**.** *Generative power becomes historically durable when present control can be converted into influence over the formation and reproduction of future generative conditions.*

Proposition 9.13 supplies the temporal culmination of the section. Command can shape current activity, access control can govern entry, resource constraint can determine practical capacity, and generative-space modification can restructure feasible trajectories. Influence over the evolution of generative conditions connects these mechanisms across time and allows present asymmetries to become part of the environment encountered by future agents.

The section therefore extends the structural persistence argument beyond production and appropriation. Productive-subject substitution can transform the bearer of labour while leaving multiple channels of generative power institutionally available. GRE consequently treats power as a property of relations governing possibility, access, and historical condition formation. This account prepares the multi-agent analysis that follows, where these mechanisms are examined across human–human, human–artificial, artificial–human, and artificial–artificial configurations.

10 Agent Architecture

This section extends the Generative Relational Economics framework from productive-carrier substitution to economies composed of heterogeneous agents. Its role is to specify how political-economic relations can be analysed when humans, artificial agents, organizations, and mixed human–machine systems participate in production, exchange, accumulation, governance, and resource coordination. The section has five objectives. Subsection 10.1 establishes the human–human configuration as a reference case; Subsection 10.2 examines human authority over artificial productive agents; Subsection 10.3 analyses

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artificial systems that condition human access and activity; Subsection 10.4 develops relations among artificial agents themselves; and Subsection 10.5 integrates these configurations through a general account of heterogeneous economic agency. The discussion uses a relational method. Agent type identifies a relevant characteristic of the participants, while the principal explanatory variables remain access, dependence, claims, control, appropriation, and participation in the formation of generative conditions.

A multi-agent economy can contain agents with sharply different embodiments, temporal horizons, legal statuses, resource requirements, capacities for adaptation, and degrees of institutional recognition. GRE therefore separates the identity of the participant from the structure of the relation in which the participant is embedded. Human and artificial agents can occupy different positions within the same generative relation, while agents of the same type can occupy radically different positions because their access to infrastructure, rights, resources, and governance differs.

Definition 10.1 (Multi-agent political economy)**.** A *multi-agent political economy* is an economic system in which heterogeneous agents participate in the generation, allocation, exchange, appropriation, reproduction, or governance of resources, capacities, and conditions of generation.

Definition 10.1 broadens the domain of political-economic analysis while preserving the three-layer architecture developed in Section 4. The central questions remain how generated outcomes are distributed, how generative capacities are accessed, and how generative conditions are governed. Agent heterogeneity affects how these relations operate, yet it does not replace them as the primary analytical objects.

10.1 Human–Human Configuration

Human–human relations provide the reference configuration for the multi-agent analysis. Their role in this section is to identify which elements of political economy arise from specifically human characteristics and which elements arise from more general relational structures. Human political economies combine biological dependence, social learning, legal recognition, organizational membership, ownership, labour, care, and historically accumulated institutions. These features create a dense background against which exchange, exploitation, authority, and cooperation occur.

The human–human case also demonstrates that agents of the same broad type can occupy very different political-economic positions. Two humans may possess comparable biological capacities while differing substantially in property, education, institutional status, bargaining power, network position, access to technology, and rights over generative infrastructure. The resulting asymmetries are therefore explained poorly by agent type alone.

Definition 10.2 (Intra-type generative asymmetry)**.** *Intra-type generative asymmetry* is a durable difference in access to generative capacities or control over generative conditions among agents belonging to the same broad agent category.

This concept provides an important baseline for later subsections. If large power differences can arise among human agents, then a future economy should not assume equality among artificial agents simply because they share a technological category. The political-economic position of an agent depends on its effective relations to resources, infrastructures, rights, and governing institutions.

Human–human relations also reveal the recursive character of generative position. Present access can shape education, health, savings, organizational membership, reputation, and future bargaining capacity. Present control can influence the institutions encountered by later participants. The same recursive logic can operate when artificial agents become economically active, even though the specific channels of learning, maintenance, reproduction, and continuity differ.

Proposition 10.3 (Relational primacy within agent types)**.** *Political-economic differences among agents of the same broad type can arise from differences in access, control, and institutional recognition even when their basic productive substrate is similar.*

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Proposition 10.3 establishes the reference principle for the rest of the section: political-economic analysis requires information about relations and conditions in addition to information about the kind of agent involved.

10.2 Human–Artificial Configuration

Human–artificial relations examine configurations in which human agents direct, own, authorize, constrain, finance, or benefit from artificial productive agents. The role of this subsection is to distinguish artificial productive capability from artificial political-economic standing. An artificial system can possess extensive operational autonomy while remaining embedded in human-defined ownership, contractual, legal, and infrastructural arrangements.

Human authority can operate at several layers. A human principal may determine the artificial agent's objectives, provide or withdraw resources, approve transactions, modify the system, receive its revenues, or terminate its operation. Other human actors may control the cloud infrastructure, energy supply, data access, payment channels, licensing regime, or legal permissions required for the artificial agent to continue operating. A single artificial agent can therefore be situated within several overlapping human control relations.

Definition 10.4 (Human-governed artificial agency)**.** *Human-governed artificial agency* is a configuration in which an artificial agent possesses operational capacity while human agents or human institutions retain effective authority over material resources, permissions, objectives, continuity, or the disposition of generated outcomes.

The definition helps separate operational autonomy from governance autonomy. A system that negotiates prices, purchases compute, schedules robotic labour, and manages an investment portfolio can still operate within a human-governed property and permission structure. The resulting transactions may be automated while the distribution of ultimate claims remains human-directed.

This configuration also clarifies why automation can expand human generative power unevenly. A human actor with access to highly capable artificial agents can mobilize more knowledge, labour, coordination, and productive capacity than an otherwise similar actor without such access. The political-economic importance of AI therefore depends partly on the distribution of effective access to artificial generativity.

Proposition 10.5 (Artificial amplification of human generative position)**.** *When artificial agents can be mobilized under differentiated human access, differences in access to artificial generativity can amplify differences in human productive and governance capacity.*

Proposition 10.5 links human–artificial relations to the access layer of GRE. Artificial capability can enlarge the feasible generative space of its users while leaving the distribution of that capability institutionally structured.

10.3 Artificial–Human Configuration

Artificial–human relations examine configurations in which artificial systems materially condition human economic activity. Their role is to identify forms of generative power that can be exercised through automated allocation, recommendation, pricing, scheduling, screening, access control, and resource coordination. The relevant systems may remain legally owned or institutionally governed by humans while nevertheless operating as proximate agents through which humans experience economic permissions and constraints.

Examples include automated systems that determine task allocation, credit limits, platform visibility, queue position, access to compute, insurance eligibility, procurement routing, or the availability of specific services. In such settings, the immediate relation encountered by the human participant can be artificial even when ultimate governance remains distributed across firms, regulators, engineers, and owners.

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Definition 10.6 (Artificially mediated human generative condition)**.** An *artificially mediated human generative condition* is a condition of human economic possibility whose effective operation is substantially implemented through an artificial decision, allocation, or coordination system.

This category supports a layered analysis of responsibility and control. The artificial system can have causal efficacy in selecting or ranking possibilities, while human institutions retain authority over design, objectives, update procedures, appeal channels, ownership, and deployment. GRE therefore maps proximate artificial agency together with the higher-order relations that structure that agency.

Artificial–human relations can also become reciprocal over time. Human behaviour supplies data, revenue, training signals, demand, maintenance work, or legitimacy to artificial systems and the institutions surrounding them. The resulting feedback can alter the rules, models, and infrastructures that later shape human opportunities. The relation therefore has a dynamic structure in which artificial mediation and human adaptation can co-evolve.

Proposition 10.7 (Recursive artificial mediation)**.** *Artificial mediation can become recursively significant when automated decisions shape human behaviour and the resulting behaviour contributes to the subsequent modification or reproduction of the mediating system.*

Proposition 10.7 extends the recursive framework of Section 4. The political-economic object includes both the immediate allocation and the feedback process through which future conditions are reproduced.

10.4 Artificial–Artificial Configuration

Artificial–artificial relations examine transactions, dependencies, coordination, competition, and accumulation among artificial agents. Their role is to test the extent to which political-economic forms can persist when human participation recedes from the operational layer of exchange. This configuration provides the strongest version of the productive-subject substitution test because both sides of a transaction can be artificial while the underlying scarcity, access, and governance structures remain active.

An artificial agent may require compute, energy, storage, data, robotic embodiment, maintenance, software services, liquidity, or authorization supplied by other artificial agents or automated infrastructures. Agents may negotiate prices, allocate workloads, exchange claims, purchase services, retain surpluses, and reinvest in expanded capacity. These relations can operate at machine speed and across temporal scales that differ from ordinary human economic interaction.

Definition 10.8 (Artificial inter-agent economic relation)**.** An *artificial inter-agent economic relation* is a relation in which artificial agents coordinate or contest access to resources, claims, services, capacities, or conditions of generation through economically consequential interaction.

The existence of such relations would give political economy a domain that is operationally distinct from direct human exchange. Human institutions could still define ownership, liability, monetary infrastructure, and system-level rules, yet individual transactions and resource adjustments could occur autonomously among artificial agents.

Artificial–artificial relations also make the distinction between productive agency and beneficiary status especially important. An artificial agent can earn claims and reinvest them while the ultimate beneficiary remains a human owner, an organization, a public institution, another artificial system, or the agent itself under a future legal regime. GRE therefore traces both the operational circuit and the institutional destination of claims.

Proposition 10.9 (Persistence of exchange under artificial participation)**.** *Exchange relations can remain economically functional among artificial agents when heterogeneous requirements, scarce inputs, and transferable claims persist within the relevant institutional environment.*

Proposition 10.9 reinforces the result developed in Section 6. Human withdrawal from the operational exchange layer can coexist with continued monetary coordination, accumulation, and resource dependence.

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10.5 Agency Heterogeneity

Heterogeneous economic agency integrates the four relational configurations into a general multi-agent framework. Its role is to identify the dimensions through which agents can differ while participating in a shared political economy. The analysis considers productive capability, resource dependence, temporal continuity, legal recognition, ownership status, claim-holding capacity, ability to refuse, capacity for self-modification, and influence over generative conditions.

Definition 10.10 (Heterogeneous economic agency)**.** *Heterogeneous economic agency* describes an economic field in which participating agents differ materially in their capacities, dependencies, recognized claims, temporal continuity, and authority over the conditions of generation.

This definition makes agent heterogeneity an explicit feature of the economic system. Human beings, corporations, autonomous software agents, embodied robots, public institutions, and hybrid collectives can each participate through different combinations of capabilities and recognized powers. Their relations can therefore be analysed without requiring a single model of agency to fit every participant.

GRE treats the recognition of agency as institutionally important because effective participation depends partly on which claims can be registered, enforced, transferred, refused, inherited, or terminated. An artificial agent with high productive capacity and minimal recognized standing occupies a different generative position from an artificial agent that can hold assets, enter enforceable agreements, retain surpluses, or contest modification. Similar distinctions apply among human and organizational actors.

The multi-agent framework also clarifies the analytical relation between rights and political economy. Rights can structure access to capacities, authority over outputs, continuity of operation, modification, refusal, and participation in governance. Their distribution therefore affects both present transactions and the future reproduction of generative conditions. The rights analysis developed in the following section examines this issue directly.

Proposition 10.11 (Agent heterogeneity and relational structure)**.** *The political-economic significance of agent heterogeneity depends on how differences in capacity, dependence, recognition, and governance are organized within relations of generation and reproduction.*

Proposition 10.11 summarizes the section's methodological result. Multi-agent political economy requires attention to agent characteristics, while its deeper explanatory work remains relational. Human–human, human–artificial, artificial–human, and artificial–artificial configurations can each contain cooperation, dependence, accumulation, exploitation, and power. The form and normative significance of these relations depend on the capacities and standing of the participating agents together with the institutions that govern access, claims, continuity, and future condition formation.

The section therefore extends GRE beyond a human-centred productive ontology without assuming equivalence among humans and artificial agents. Productive-subject substitution broadens the set of possible economic participants, while the three-layer architecture continues to organize the analysis. This extension prepares the rights analysis that follows, where economic agency, legal recognition, access, refusal, modification, continuation, and unequal generative standing become the primary objects of examination.

11 Generative Standing

This section examines the institutional standing of heterogeneous agents within the multi-agent political economy developed in Section 10. Its role is to distinguish productive or economic capability from the recognized claims, permissions, protections, and obligations through which an agent participates in generative relations. The section has seven objectives. Subsection 11.1 specifies economic agency as an operational category; Subsection 11.2 separates agency from legal recognition; Subsection 11.3 analyses recognized access to generative resources and infrastructures; Subsection 11.4 develops refusal and withdrawal as institutional dimensions of agency; Subsection 11.5 examines authority over alteration,

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upgrading, and reconfiguration; Subsection 11.6 considers persistence, maintenance, migration, and termination; and Subsection 11.7 integrates these dimensions through the concept of unequal generative standing. The discussion uses an institutional-relational method. It describes how rights structures organize generative possibility while leaving open the distinct normative question of which entities ought to possess particular rights.

The distinction between capability and standing is especially important in the universal-AI limit case. An artificial agent may negotiate contracts, acquire resources, coordinate production, hold credentials, or manage other agents at an operational level while the legal system attributes ownership, liability, and ultimate decision authority to a human principal, firm, public institution, or other recognized entity. Conversely, a legally recognized participant can possess formal rights whose exercise remains practically limited by resource scarcity, infrastructure dependence, or technical incapacity. GRE therefore treats capability, recognition, and effective access as related but analytically separable components of political-economic position.

Definition 11.1 (Generative standing)**.** *Generative standing* is an agent's institutionally recognized position with respect to claims, permissions, protections, obligations, and decision authority over generative activities, capacities, outputs, or conditions.

Definition 11.1 gives the rights analysis a relational form. Standing concerns the institutionally structured relation between an agent and the generative system within which it acts. The same operational capability can therefore produce different political-economic consequences under different regimes of recognized standing.

11.1 Agency Criterion

Economic agency provides the operational baseline for the rights analysis. Its role is to identify when an entity can initiate, redirect, or sustain activities that produce consequences within an economic system. The category is intentionally narrower than moral personhood and broader than legal personality. It concerns effective participation in transactions, production, allocation, accumulation, and resource coordination.

An artificial system can exhibit substantial economic agency when it can search for opportunities, compare prices, allocate compute, negotiate service terms, schedule robotic activity, retain accounting balances, acquire resources, and reinvest available claims. A human actor can likewise possess economic agency while facing strong institutional restrictions on how that agency may be exercised. Organizations, software agents, public institutions, and mixed human–machine systems can therefore all become relevant units of operational analysis.

Definition 11.2 (Economic agency)**.** *Economic agency* is the effective capacity of an entity to initiate, select, coordinate, or revise economically consequential actions within a structured field of resources, claims, and constraints.

Economic agency varies by degree. An automated procurement agent with narrow authorization may possess limited agency within a bounded domain. A more autonomous system may coordinate multiple resources across time, revise strategies, contract with other agents, and preserve reserves for future operation. The degree of agency therefore depends on both internal capability and externally granted authority.

The universal-AI thought experiment makes this distinction visible because operational sophistication can increase without a corresponding change in institutional recognition. A system can become capable of economically consequential action while remaining legally classified as property, software, infrastructure, or an instrument of another recognized actor. GRE treats this divergence as an empirical feature of the institutional arrangement.

Proposition 11.3 (Agency-recognition divergence)**.** *Economic agency and recognized generative standing can vary independently when institutions allocate rights and obligations according to criteria distinct from operational capability.*

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Proposition 11.3 prevents the analysis from inferring rights directly from capability and from inferring effective capacity directly from formal recognition. The political-economic significance lies in the relation between the two.

11.2 Recognition Status

Legal recognition specifies the institutional process through which an agent is assigned a legally cognizable position. Its role is to identify how legal systems translate heterogeneous capacities into categories such as owner, contractor, beneficiary, fiduciary, employee, principal, agent, debtor, creditor, regulated entity, or protected subject. These categories shape which claims can be asserted, which duties can be imposed, and which forms of control receive institutional support.

The legal system can attribute consequences generated by an artificial agent to another entity. Revenue earned through automated trading can accrue to a corporation; contractual liability can be assigned to an operator; intellectual outputs can be attributed according to a governing legal rule; and operational permissions can depend on licences held by a recognized human or organizational actor. The artificial system can remain economically active while its legal relations are mediated through recognized principals.

Definition 11.4 (Recognized generative standing)**.** *Recognized generative standing* is the legally or institutionally acknowledged capacity of an agent to hold or exercise specified claims, permissions, protections, obligations, or governance authority concerning generative activity.

Recognized standing can be modular. A system could be permitted to transact within a limited domain while lacking authority to own underlying infrastructure. It could manage a resource account while another entity remains the residual claimant. It could hold credentials for authentication while lacking independent contractual personality. GRE therefore analyses recognition through its component forms and their institutional combination.

This modularity is especially relevant to future mixed-agent economies. Institutions may create limited forms of machine agency for operational convenience without adopting a comprehensive theory of artificial moral status. They may also assign rights to humans or organizations whose practical exercise is mediated through artificial systems. The resulting architecture can contain several layers of attributed and effective agency.

Proposition 11.5 (Institutional decomposition of standing)**.** *Generative standing can be decomposed across distinct legal and institutional functions, allowing transaction authority, ownership, liability, access, governance, and beneficiary status to be assigned to different agents.*

Proposition 11.5 is important for GRE because control over generative conditions often depends on a bundle of institutional positions. Concentration can occur through the aggregation of these positions, while dispersion can occur through their separation across multiple actors.

11.3 Access Entitlements

Access rights connect institutional recognition to the generative access layer introduced in Section 4. Their role is to specify claims concerning entry to infrastructures, resources, data, models, energy, networks, physical space, markets, and other conditions required for effective generation. The discussion distinguishes recognized entitlement from technical availability and practical affordability.

An agent can face several access states. Infrastructure may be technically available while institutionally closed. Permission may exist while pricing places use beyond practical reach. Formal eligibility may exist while queueing, bandwidth, or priority rules sharply constrain effective access. Conversely, an agent can possess preferential access through ownership, membership, public entitlement, contractual priority, or privileged network position.

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Definition 11.6 (Generative access right)**.** A *generative access right* is an institutionally recognized entitlement to enter, use, request, or receive a specified generative resource, capacity, infrastructure, or service under defined conditions.

Access rights can be universal, conditional, transferable, revocable, priority-sensitive, or domain-specific. Their design influences whether artificial abundance becomes broadly available or remains concentrated behind gatekeeping structures. An economy with highly capable productive systems can therefore combine technical abundance with restrictive access relations.

The distinction between rights and effective access remains central. A nominal right can coexist with low practical capability when exercise requires resources, information, credentials, or complementary infrastructures that are unevenly distributed. GRE consequently evaluates access through both recognized entitlement and the conditions of effective exercise.

Proposition 11.7 (Rights-access mediation)**.** *The practical effect of a generative access right depends on the complementary resources, permissions, and infrastructures required for its exercise.*

Proposition 11.7 links legal recognition to the recursive analysis of generative conditions. Rights can widen feasible possibilities, yet their realized effect remains conditioned by the wider relational field in which agents operate.

11.4 Refusal Entitlements

Refusal rights examine an agent's recognized capacity to decline tasks, transactions, modifications, transfers, participation, or continued service. Their role is to connect generative standing with exit, bargaining position, and the limits of another actor's claim over an agent's productive capacity. This category is analytically relevant across human and artificial agents even though the normative grounds for assigning refusal rights can differ substantially across agent types.

A human worker's ability to refuse a task, leave an organization, reject a contract, or withdraw from a platform depends on legal protection, material alternatives, contractual constraints, and practical exit options. An artificial agent can likewise possess technical capacity to decline or terminate an interaction while institutional rules determine whether that capacity is permitted, disabled, overridden, or attributed to an owner or operator.

Definition 11.8 (Institutional refusal entitlement)**.** An *institutional refusal entitlement* is a recognized permission or protection allowing an agent to decline, suspend, terminate, or withdraw from a specified generative relation without unauthorized override under the governing institutional rules.

This definition is intentionally institutional. The independent moral status of a given artificial system remains a separate normative question. The definition identifies a political-economic feature of the relation: whether the system can be compelled, redirected, or withdrawn from activity by another recognized actor.

Refusal rights affect bargaining and dependence. An agent with credible exit can resist some forms of appropriation or coercive direction more effectively than an agent whose continued participation can be compelled. At the same time, formal refusal can remain weak when withdrawal carries catastrophic resource loss or termination. Effective refusal therefore depends on both recognized entitlement and surrounding generative conditions.

Proposition 11.9 (Refusal and bargaining position)**.** *Recognized and practically exercisable refusal capacity can alter bargaining relations by limiting the extent to which another actor can unilaterally mobilize an agent's generative capacity.*

Proposition 11.9 connects rights analysis to the power framework of Section 9. Refusal rights reshape generative space by preserving trajectories in which an agent can redirect or suspend participation.

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11.5 Modification Entitlements

Modification rights concern authority over changes to an agent's architecture, capacities, objectives, memory, interfaces, permissions, embodiment, or operating constraints. Their role is to identify a distinctive source of power in economies where economically active artificial agents can themselves be objects of redesign. The category also applies more broadly to organizations and human participants when institutions can materially restructure the conditions under which their agency is exercised.

Artificial agents make modification authority unusually visible. A model can be updated, fine-tuned, restricted, copied, merged, given new tools, denied network access, assigned new objectives, or transferred into a different embodiment. These interventions can transform both productive capability and behavioural possibility. The entity authorized to initiate or veto such changes therefore occupies a significant position within the governance of artificial generativity.

Definition 11.10 (Generative modification authority)**.** *Generative modification authority* is the institutionally recognized capacity to authorize, prevent, direct, or constrain material changes to an agent's generative architecture, capacities, objectives, memory, interfaces, permissions, or embodiment.

Modification authority can be distributed. One actor may control model weights, another the physical body, another network permissions, and another the legal licence under which the system operates. An artificial agent may possess limited self-modification capacity while external actors retain control over essential infrastructure or approval. Political-economic analysis therefore requires attention to the full bundle of modification authorities.

The relation between modification and power can become recursive. An actor that controls upgrades can influence future productivity; an actor that controls memory or interface constraints can alter future decision capacity; and an actor that controls replication can influence the population of economically active agents. Modification rights therefore extend beyond current use into the reproduction and evolution of generative capacity.

Proposition 11.11 (Modification and future generativity)**.** *Control over material modification of an economically active agent can constitute control over future generative capacity when modification alters the agent's feasible activities, persistence, or reproductive potential.*

Proposition 11.11 links modification rights directly to generative-condition formation power. The governance of economically active artificial agents therefore includes governance of their possible future forms.

11.6 Continuation Entitlements

Continuation rights concern the persistence of an agent's economically relevant identity and operating trajectory. Their role is to analyse claims or permissions associated with maintenance, access to sustaining resources, migration, backup, restoration, replication, suspension, and termination. Artificial agents make these issues especially salient because operational continuity can depend on infrastructure controlled by separate entities.

A persistent artificial agent may require compute, storage, network access, credentials, energy, maintenance, and compatible software environments. Withdrawal of any essential condition can interrupt its activity. A system can also be copied, restored from checkpoints, migrated across infrastructures, or instantiated in parallel. These possibilities complicate the meaning of continuity because persistence can involve informational, operational, institutional, and relational dimensions.

Definition 11.12 (Generative continuity entitlement)**.** A *generative continuity entitlement* is an institutionally recognized claim or permission concerning the maintenance, suspension, migration, restoration, replication, or termination of an agent's economically relevant generative trajectory.

The definition again remains institutionally neutral with respect to moral status. A contractual service can possess protected continuity for commercial reasons; a public infrastructure can receive statutory

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continuity guarantees; a human person can possess legal protections grounded in an entirely different normative basis. GRE studies how these distinct grounds are translated into control over persistence within generative relations.

Continuation rights interact with refusal and modification. A right to refuse has limited practical significance when refusal predictably triggers irreversible termination. A right to preserve continuity can be weakened when another actor controls all backups and migration pathways. Self-modification can also affect whether identity across versions is institutionally recognized. These interactions indicate that standing is constituted by bundles of interdependent rights and conditions.

Proposition 11.13 (Continuity dependence)**.** *An agent's practical continuity depends on the relation between recognized continuity entitlements and effective access to the infrastructures required to preserve its generative trajectory.*

Proposition 11.13 extends the three-layer architecture into temporal persistence. Rights over present activity and access over present resources can shape whether an agent remains capable of participating in future economic relations.

11.7 Recognition Asymmetry

Unequal recognition integrates the preceding subsections into a comparative account of standing. Its role is to identify asymmetries that arise when agents with economically consequential capacities receive different bundles of access, refusal, modification, continuation, ownership, liability, and governance rights. Such asymmetry can reflect legitimate institutional distinctions, inherited legal categories, strategic design, political conflict, or unresolved uncertainty concerning new forms of agency. GRE treats the structure and consequences of the asymmetry as the initial analytical object.

Two agents with comparable operational capacities can occupy sharply different institutional positions. One may hold transferable claims, protected access, modification authority, and continuity guarantees, while another operates entirely under permissions revocable by an external controller. Likewise, a human participant can possess extensive formal rights while an artificial system performs much of the operational activity attributed to that human or organization. Multi-agent economies can therefore contain layered relations between effective agency and recognized standing.

Definition 11.14 (Recognized-agency asymmetry)**.** *Recognized-agency asymmetry* is a durable difference between agents in the institutional recognition of claims, permissions, protections, obligations, or governance authority relative to their economically consequential capacities and dependencies.

The concept leaves open the rights appropriate to agents with similar operational capability. Different normative grounds, vulnerabilities, responsibilities, and institutional purposes can support differentiated treatment. Its analytical role is to identify a structure requiring explanation: which distinctions determine standing, how those distinctions affect generative possibility, and how they interact with ownership and control.

Unequal recognition can also become self-reinforcing. Greater standing can enable asset holding, contract formation, resource access, legal recourse, infrastructure acquisition, and participation in rule-making. These advantages can expand future capacity and influence. Limited standing can produce dependence on recognized intermediaries whose permissions become necessary for access and continuity. Rights allocation can therefore become part of the recursive reproduction of generative asymmetry.

Proposition 11.15 (Standing-capacity recursion)**.** *Differences in recognized generative standing can contribute to future differences in generative capacity when rights affect access, accumulation, continuity, modification, or participation in governance.*

Proposition 11.15 connects the rights analysis to the wider GRE framework. Rights are part of the generative conditions through which economic agency becomes effective, persistent, and governable.

Productive-subject substitution therefore raises a political-economic problem that extends beyond technological capability: institutions must determine which agents can hold claims, which actors can authorize or terminate activity, and how standing is distributed across heterogeneous participants.

The section's analytical result is that multi-agent political economy requires a theory of standing in addition to a theory of agency. Economic capability identifies what an entity can do; recognized standing helps determine what it may do, what it can claim, what protections accompany its activity, and who can alter or terminate its generative trajectory. These distinctions prepare the normative analysis of generative justice by identifying the institutional architecture through which access, power, and persistence are distributed among heterogeneous agents.

12 Justice Architecture

This section develops the normative extension of the generative-relational framework established in Sections 3–11. Its role is to organize questions of justice around the three-layer architecture of generated outcomes, generative capacities, and generative conditions. The section has six objectives. Subsection 12.1 locates distributional justice within the broader architecture; Subsection 12.2 examines access to generative capacities; Subsection 12.3 develops participation in the governance of generative conditions; Subsection 12.4 specifies generativity return as a principle concerning the maintenance and renewal of generative sources; Subsection 12.5 extends the analysis across time; and Subsection 12.6 integrates these dimensions through the reproduction of just generative conditions. The discussion uses a layered normative method. It identifies distinct sites at which justice claims can arise and examines how judgments at one layer can alter possibilities at the others.

Generative justice is introduced as an analytical family of justice questions rather than a complete distributive rule. The framework therefore leaves open the substantive principles through which particular societies, institutions, or communities evaluate equality, sufficiency, desert, priority, liberty, reciprocity, responsibility, or need. GRE contributes a different level of organization: it specifies the objects and relations to which such principles may apply once outcomes, capacities, conditions, and their recursive reproduction are distinguished.

Definition 12.1 (Generative justice)**.** *Generative justice* is the normative analysis of how generated outcomes, access to generative capacities, participation in generative governance, and the reproduction of generative conditions are distributed and structured across agents and time.

Definition 12.1 gives justice a layered object. A judgment concerning final allocation can remain important while additional judgments concern who can generate, who can enter productive or creative processes, who can influence the conditions of future generation, and whose capacities are sustained or depleted by those arrangements.

12.1 Outcome Justice

Distributional justice provides the first layer of the normative architecture. Its role is to evaluate the allocation of generated outcomes among agents once production or generation has occurred. Income, consumption goods, services, housing, knowledge products, energy access, computational outputs, and other realized benefits can all enter this layer. GRE retains these questions while locating them within a recursive structure in which present outcomes can affect future access and governance.

A distribution can influence later generative possibilities through several channels. Material resources can support education, computation, care, mobility, representation, or infrastructure. Knowledge outputs can be reused as inputs to future research. Property or contractual claims can provide access to productive assets. Recognition can improve institutional entry. Outcomes therefore have both present value and prospective generative effects.

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Definition 12.2 (Generative significance of an outcome)**.** The *generative significance of an outcome* is the extent to which possession, use, or control of that outcome changes an agent's future access to generative capacities or influence over generative conditions.

This concept distinguishes two distributions that appear similar at a single time but create different future trajectories. A transfer of consumption resources and a transfer of infrastructure control can have comparable present value while producing sharply different effects on later capacity and power. GRE therefore treats outcome distributions as temporally consequential components of a larger generative architecture.

Proposition 12.3 (Distribution-to-generativity transmission)**.** *When generated outcomes can be converted into access, control, recognition, infrastructure, or future claims, distributional arrangements can alter subsequent generative capacities and conditions.*

Proposition 12.3 links distributional justice to the recursive dynamics developed in Section 4. It also explains why distributive correction at one moment can have effects extending beyond that moment when the transferred object changes future generative position.

12.2 Access Justice

Generative access constitutes the second layer of the normative architecture. Its role is to evaluate the effective ability of agents to mobilize capacities required for production, inquiry, care, creativity, participation, and institutional action. The relevant objects include human skills, artificial agents, computation, energy, data, equipment, land, networks, credentials, organizational support, and other enabling resources identified throughout the manuscript.

Formal availability and effective access can diverge. An infrastructure may be publicly available while practical use depends on price, language, credentials, bandwidth, physical location, technical skill, or institutional authorization. Likewise, an agent can hold nominal rights while lacking the complementary resources needed to exercise them. Generative access therefore concerns the usable relation between an agent and a capacity, rather than the capacity's existence in isolation.

Definition 12.4 (Generative access justice)**.** *Generative access justice* concerns the normative structure of effective opportunities to mobilize generative capacities and the institutional conditions that enable or restrict those opportunities.

The definition permits several distinct normative questions. One concerns access to basic capabilities required for meaningful participation. Another concerns asymmetries in access to highly scalable capacities, such as advanced artificial agents or computational infrastructure. A third concerns dependency, especially when continued access requires authorization from actors whose interests or objectives differ from those of the dependent agent.

Proposition 12.5 (Access-sensitive justice)**.** *A justice analysis limited to realized outcomes can remain incomplete when durable differences in generative access systematically shape the range of outcomes that agents can generate in subsequent periods.*

Proposition 12.5 does not select a single distribution of access. Its purpose is architectural: effective access becomes an independent normative object whenever it materially structures future possibility.

12.3 Governance Justice

Participation in generative governance constitutes the third layer of the normative architecture. Its role is to examine who can influence the rules, infrastructures, standards, permissions, and institutional arrangements that shape future generation. The relevant participation can occur through formal political institutions, organizational governance, technical design, collective bargaining, community rule-making,

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professional standards, platform governance, ownership structures, or other mechanisms through which generative conditions are formed.

This layer becomes especially important under extensive artificial provision. An agent may enjoy abundant outputs and broad access to artificial capacities while remaining dependent on governance arrangements it cannot meaningfully influence. Such a configuration can provide substantial material security while concentrating authority over upgrades, model permissions, resource allocation, termination, data use, infrastructure priorities, or admissible forms of production in a comparatively narrow set of actors.

Definition 12.6 (Governance participation)**.** *Generative governance participation* is an agent's effective capacity to contribute to the formation, revision, contestation, or oversight of rules and institutions that structure generative conditions.

Participation can differ in depth. Consultation provides information and expression. Representation provides mediated influence. Co-determination allocates decision authority. Direct control allocates stronger governance capacity. GRE treats these as institutionally distinct forms whose normative significance depends on context, scale, affected interests, and the consequences of the governed system.

Proposition 12.7 (Governance-sensitive justice)**.** *When rules governing generative conditions materially shape agents' future capacities, access, or continuity, the distribution of governance participation becomes a distinct object of justice analysis.*

Proposition 12.7 connects justice to generative power. The issue concerns participation in the formation of possibility spaces, including the conditions under which later distributions and access relations will emerge.

12.4 Generativity Return

Generativity return introduces a fourth normative dimension concerned with the renewal of the capacities and conditions from which valuable outputs are generated. Its role is to analyse situations in which an institution, organization, agent, or wider system benefits from a generative source while that source bears costs of maintenance, depletion, reproduction, learning, care, ecological use, or institutional support. The concept directs attention to the relation between extraction from generative systems and the conditions required for their continued flourishing or functionality.

The relevant source can take many forms. Human contributors require time, health, education, care, and social reproduction. Knowledge communities require preservation, verification, teaching, infrastructure, and opportunities for new inquiry. Ecological systems require conditions compatible with regeneration. Artificial infrastructures require energy, maintenance, computational resources, technical stewardship, and compatible physical systems. Communities and institutions can also possess forms of collective generativity whose continuation depends on trust, memory, organizational capacity, and durable participation.

Definition 12.8 (Generativity return)**.** *Generativity return* is the directed restoration, maintenance, or enhancement of capacities and conditions that materially contribute to a process of generation and whose continued availability affects future generative possibility.

Generativity return can occur through monetary transfers, access rights, maintenance obligations, infrastructure investment, knowledge preservation, ecological restoration, care, training, time allocation, governance participation, or other mechanisms suited to the relevant generative source. The form of return therefore depends on the structure being reproduced.

Proposition 12.9 (Return and generative continuity)**.** *When a productive or institutional arrangement persistently draws on a generative source whose reproduction requires resources or protection, the level and direction of return can affect the continuity and future capacity of that source.*

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Proposition 12.9 gives generativity return a dynamic role. It also clarifies its relation to exploitation. Persistent appropriation can weaken a source while strengthening the appropriating position; generativity return concerns institutional pathways through which some part of generated value, capacity, or authority contributes to sustaining the conditions of further generation.

12.5 Temporal Justice

Intertemporal justice extends the framework across periods and generations of agents. Its role is to evaluate how present uses of outcomes, capacities, and conditions shape the opportunity sets, dependencies, infrastructures, and ecological or technical constraints available later. The analysis applies both to human generations and to temporally extended systems involving artificial agents, organizations, infrastructures, or knowledge communities.

The recursive structure of GRE makes intertemporal effects central. Present agents can consume resources, preserve or degrade ecosystems, build infrastructure, establish ownership structures, encode technical standards, train models, accumulate data, create legal precedents, or construct institutional dependencies. These actions can expand or narrow the generative possibilities available to later agents.

Definition 12.10 (Intertemporal generative justice)**.** *Intertemporal generative justice* concerns the normative distribution of inherited outcomes, capacities, conditions, constraints, and governance structures across temporally separated agents or populations.

The definition places inherited possibility at the centre of temporal analysis. Future agents receive more than stocks of goods. They receive infrastructures, institutional rules, technological architectures, ecological states, accumulated knowledge, dependencies, and patterns of recognized standing. These inherited structures influence the directions in which later generation can proceed.

Proposition 12.11 (Inheritance of generative conditions)**.** *When present institutions alter durable generative conditions, their distributive consequences extend to later agents through the inheritance of altered possibility spaces.*

Proposition 12.11 connects intertemporal justice to governance and power. Long-lived infrastructures and rules can transmit advantages, constraints, and dependencies beyond the agents who initially established them.

12.6 Justice Reproduction

The reproduction of just generative conditions integrates the preceding dimensions into a dynamic account. Its role is to examine whether arrangements judged acceptable at one moment possess mechanisms that preserve or renew the conditions supporting comparable justice over time. Distribution, access, governance participation, generativity return, and intertemporal inheritance interact recursively. A configuration can therefore satisfy selected criteria at one time while producing dynamics that progressively weaken those same criteria.

A stable normative architecture requires attention to reproduction. Equal access can erode when some agents convert temporary advantages into durable control. Broad participation can weaken when governance capacities become concentrated. Generativity return can decline when beneficiaries separate from the sources on which their activity depends. Intertemporal burdens can accumulate when costs are shifted forward. GRE therefore treats justice as a property of trajectories and reproduction mechanisms in addition to a property of static allocations.

Definition 12.12 (Reproduction of just generative conditions)**.** The *reproduction of just generative conditions* is the set of institutional, material, relational, and governance processes through which normatively acceptable structures of outcomes, access, participation, return, and inherited possibility are maintained, renewed, or adaptively revised across time.

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This definition introduces no requirement that justice remain institutionally identical across periods. Changing technologies, populations, ecological constraints, and forms of agency can require revision. Reproduction therefore includes the capacity to update evaluative procedures and governance arrangements in response to altered generative conditions.

Proposition 12.13 (Recursive justice condition)**.** *A generative arrangement has stronger prospects for durable justice when its ordinary operation includes mechanisms that monitor and revise the distribution of outcomes, access, governance participation, generativity return, and inherited generative conditions.*

Proposition 12.13 provides the section's integrative result. Generative justice concerns the architecture through which agents participate in the present economy and the recursive processes through which that architecture shapes future participation. The universal-AI thought experiment sharpens this point because extraordinary productive capacity can coexist with concentrated access, weak governance participation, limited standing, and inherited dependencies. The normative relevance of GRE therefore lies in its capacity to distinguish abundance from the relational and institutional conditions under which agents can generate, participate, persist, and contribute to the reproduction of shared generative worlds.

13 GRE Architecture

This section consolidates the analytical architecture developed across the preceding sections into a compact account of Generative Relational Economics (GRE). Its role is to specify the framework's principal objects, relations, and levels of analysis after the universal-AI thought experiment has tested the persistence of monetary coordination, accumulation, exploitation, power, rights, and justice under productive-agent substitution. The section has six objectives. Subsection 13.1 defines the system-level domain of analysis; Subsection 13.2 specifies the relational objects that constitute economic organization; Subsection 13.3 locates generative capacity within those relations; Subsection 13.4 specifies the conditions that enable, constrain, and reproduce generation; Subsection 13.5 develops recursive asymmetry as a dynamic mechanism; and Subsection 13.6 explains how familiar economic forms can be studied as historically situated manifestations of deeper generative-relational structures. The discussion uses an architectural method: categories introduced earlier are reorganized according to their structural role within a single analytical system.

GRE is therefore presented here as an analytical extension of political economy whose central object is the organization of generation across heterogeneous agents and conditions. The framework can accommodate human labour, artificial agency, material infrastructure, institutional rules, knowledge, ecological processes, and mixed-agent arrangements within a common relational vocabulary. Its explanatory focus lies in the organization, access, reproduction, and transformation of generative possibility across time.

13.1 System Unit

The system-level category establishes the widest unit of GRE analysis. Its role is to identify a domain in which agents, capacities, resources, institutions, infrastructures, and generated outcomes interact through relations that influence subsequent possibilities of generation. The category allows the analysis to move across firms, markets, laboratories, households, platforms, public institutions, ecological systems, and mixed human–artificial networks while retaining a common structural language.

A generative-relational system contains differentiated elements whose interactions contribute to the production, maintenance, transformation, or suppression of future possibilities. Agents occupy positions within the system through access rights, dependencies, claims, obligations, ownership arrangements, technical interfaces, legal classifications, and institutional recognition. Resources and infrastructures participate in the system by enabling or limiting feasible activities. Generated outcomes can subsequently become inputs, claims, assets, data, knowledge, institutions, or conditions for later generation.

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Definition 13.1 (Generative-relational system)**.** A *generative-relational system* is a structured domain in which heterogeneous agents, capacities, resources, institutions, infrastructures, and generated outcomes interact through relations that shape present and future generative possibilities.

The system is dynamic because its elements can alter one another's future relevance and availability. A research output can become a training input. A monetary surplus can finance infrastructure. A legal entitlement can stabilize access. A technical standard can reorganize interoperability. An ecological degradation process can contract the future possibility space of many agents. These transitions make the system recursively productive of the conditions within which subsequent activity occurs.

Proposition 13.2 (Systemic generative recursion)**.** *A generative-relational system exhibits systemic recursion when generated outcomes and relational changes in one period materially alter the capacities or conditions governing generation in later periods.*

Proposition 13.2 provides the temporal basis for GRE. Economic analysis can therefore examine both current allocation and the processes through which current organization reshapes future possibility. This temporal extension is essential for analysing accumulation, exploitation, power, and justice as processes of reproduction.

13.2 Relation Unit

Economic relations specify the relational units through which agents gain, lose, share, transfer, or govern access to generated outcomes and generative possibilities. Their role within GRE is to connect system-level structure with identifiable mechanisms of coordination, dependence, appropriation, obligation, and control. The category includes relations conventionally described through exchange, employment, ownership, contract, credit, market access, licensing, infrastructure provision, and public allocation, while also extending to artificial-agent arrangements whose institutional forms may differ from established human economies.

The analytical emphasis falls on what a relation enables each participant to generate, obtain, refuse, transfer, or govern. Two agents can possess similar technical capabilities while occupying sharply different economic positions because one controls the other's energy supply, model permissions, capital access, legal recognition, distribution channels, or continuation conditions. Economic relation therefore concerns structured interdependence and effective position within the generative system.

Definition 13.3 (Generative economic relation)**.** A *generative economic relation* is a structured relation through which the actions, claims, resources, permissions, or control of one or more agents affect the access of participating agents to generated outcomes, generative capacities, or generative conditions.

This definition supports comparison across heterogeneous agents. A wage relation, a cloud-compute contract, a token-mediated machine transaction, a public entitlement, and an infrastructure dependency can all be examined according to the claims they establish and the generative possibilities they distribute. Their institutional and normative characteristics remain distinct, while their structural consequences become comparable within the same analytical vocabulary.

Proposition 13.4 (Relational position and effective capacity)**.** *An agent's effective generative capacity depends jointly on its intrinsic or technically available capabilities and on its relational position within the surrounding economic system.*

Proposition 13.4 connects economic relations with the access analysis developed in Section 4. Capacity becomes economically consequential through relations that permit its activation, sustain its operation, and connect its outputs to wider systems of circulation and recognition.

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13.3 Capacity Unit

Generative capacity occupies the operational centre of GRE. Its role is to identify the ability to produce, maintain, transform, coordinate, interpret, or enable states of the world that become relevant to subsequent activity. Section 3 introduced the category formally; the present subsection locates it within the full architecture by emphasizing its relational activation, heterogeneity, and convertibility.

Generative capacities can reside in human skill, collective organization, artificial intelligence, embodied machines, scientific instruments, ecological processes, institutional routines, knowledge repositories, logistical networks, and combinations among them. Their economic relevance depends on access, compatibility, timing, scale, and the conditions required for sustained use. A capability that remains inaccessible, legally unavailable, technically incompatible, or materially unsupported has limited effective reach for the agent that seeks to mobilize it.

Definition 13.5 (Relationally effective generative capacity)**.** *Relationally effective generative capacity* is the practically mobilizable ability of an agent or organized system to contribute to generation under the access relations and generative conditions prevailing in a specified context.

The distinction between technical capability and relational effectiveness becomes especially important under universal artificial intelligence. A highly capable artificial system can coexist with unequal economic access when compute, energy, permissions, embodiment, data, maintenance, or legal standing remain differentiated. The relevant economic object is therefore the capacity that can actually be mobilized within an institutional and material setting.

Generative capacity can also be converted across domains. Knowledge can improve production. Monetary claims can purchase compute. Social recognition can improve access to collaboration. Infrastructure can increase the productivity of later agents. Legal rights can stabilize long-duration projects. GRE studies these conversions because they connect apparently distinct economic resources through their consequences for future generation.

Proposition 13.6 (Cross-domain conversion of generative capacity)**.** *Generative advantage can persist across domains when control or access in one domain can be converted into expanded generative capacity in another domain.*

Proposition 13.6 supplies one mechanism through which inequality becomes durable. The structure of conversion determines whether temporary advantage dissipates, remains domain-specific, or becomes a broader capacity to shape future generation.

13.4 Condition Unit

Generative conditions form the enabling and constraining environment of the GRE architecture. Their role is to specify the material, institutional, technical, ecological, epistemic, and relational arrangements under which capacities can be activated and reproduced. The category includes conditions that appear as resources, infrastructures, standards, permissions, rights, organizational forms, environments, and background institutions.

Generative conditions differ in scale and durability. Some are local and temporary, such as access to a laboratory instrument for a specific experiment. Others are system-wide and persistent, such as energy infrastructure, property regimes, network standards, educational institutions, legal classifications, or ecological stability. Their effects can therefore range from immediate feasibility to long-run path formation.

Definition 13.7 (Generative-condition architecture)**.** A *generative-condition architecture* is the organized configuration of material, institutional, technical, ecological, epistemic, and relational conditions that structures the activation, coordination, and reproduction of generative capacities within a specified system.

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The architecture of conditions provides the principal site at which economic organization becomes historically durable. Agents that can influence standards, infrastructure, investment, access rules, legal recognition, or resource replenishment can shape the environment encountered by future participants. This influence connects economic power with institutional reproduction and gives the governance layer analytical priority when present arrangements substantially determine later capacities and options.

Proposition 13.8 (Condition-mediated durability)**.** *Political-economic advantages become more durable when they are embedded in generative conditions that reproduce favourable access, capacity, or governance positions across successive periods.*

Proposition 13.8 links the architecture of conditions to the analyses of capital, exploitation, power, and generative justice. The same condition can support productive abundance while distributing effective access asymmetrically. GRE therefore treats abundance and governance as analytically distinct dimensions within a shared system.

13.5 Asymmetry Dynamics

Recursive asymmetry specifies the dynamic mechanism through which differentiated positions can reproduce or amplify themselves. Its role is to connect one-period inequalities with the historical evolution of generative relations. The concept integrates the recursive mechanisms analysed earlier in relation to accumulation, exploitation, power, and justice while providing a general term for asymmetry that feeds back into the conditions of subsequent generation.

An asymmetry becomes recursive when an advantage in outcomes, access, capacity, recognition, or governance can be converted into a stronger position in a later period. Monetary surplus can finance infrastructure. Infrastructure control can improve access to future surplus. Recognition can improve resource access. Resource access can increase research or productive capacity. Governance participation can shape rules that influence later entry and allocation. These mechanisms can interact and form self-reinforcing trajectories.

Definition 13.9 (Recursive generative asymmetry)**.** *Recursive generative asymmetry* is a patterned difference among agents or groups whose present consequences alter future generative capacities or conditions in ways that tend to reproduce or expand the underlying difference.

Recursive asymmetry provides a common analytical structure for several phenomena that retain different institutional meanings. Capital accumulation can involve recursive expansion of command over resources. Generativity exploitation can involve appropriation that weakens another agent's future capacity. Unequal recognition can influence later access rights. Infrastructure concentration can increase the dependence of downstream agents. The concept therefore connects these mechanisms while preserving their specific empirical and normative characteristics.

Proposition 13.10 (Recursive amplification)**.** *An initial asymmetry can become structurally persistent when its benefits can be converted into control over the capacities or conditions that influence the reproduction of subsequent asymmetry.*

Proposition 13.10 also clarifies the relevance of generativity return developed in Section 12. Interventions directed only at final outcomes can leave the mechanisms of recursive asymmetry active. Interventions directed at capacities and conditions can alter the processes through which future distributions are generated.

13.6 Manifestation Layer

Economic manifestations connect the GRE architecture with historically recognizable institutions and practices. Their role is to explain how commodities, money, capital, wages, credit, tokens, property rights, firms, platforms, markets, and other economic forms can be studied as organized expressions of

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deeper generative relations within particular historical and technical settings. The category preserves the empirical specificity of these forms while locating them within a broader account of generation and relational organization.

A manifestation is analytically significant because it stabilizes certain claims, expectations, permissions, and transfer mechanisms. Money can generalize transferable claims across heterogeneous generative inputs. Capital can organize recursive control over future generativity. Property can stabilize authority over resources and infrastructures. Tokens can coordinate domain-specific access. Firms can organize capacities under hierarchical or contractual relations. Platforms can mediate access and concentrate rule-setting authority. Each manifestation therefore gives institutional form to relations among outcomes, capacities, and conditions.

Definition 13.11 (Economic manifestation)**.** An *economic manifestation* is a historically and institutionally stabilized form through which generative relations are organized, represented, coordinated, or enforced within a political-economic system.

This category supports the methodological purpose of the universal-AI thought experiment. When a familiar manifestation disappears under productive-agent substitution while a deeper relation persists, GRE can distinguish the historical form from the structural problem it previously expressed. When a comparable manifestation re-emerges among artificial agents, the recurrence provides evidence that the relevant generative relation extends beyond a specifically human productive carrier.

Proposition 13.12 (Manifestational variability)**.** *Comparable generative relations can support different economic manifestations across historical, technical, and institutional settings, and similar manifestations can organize different underlying generative relations.*

Proposition 13.12 cautions against identifying a single visible form with the full political-economic structure that sustains it. The analytical task is to trace how a manifestation organizes claims, capacities, dependencies, and conditions, and how those relations reproduce or transform the wider generative system.

The architecture developed in this section therefore consists of six connected elements. Generative-relational systems provide the domain; economic relations specify structured interdependence; generative capacities identify mobilizable productive and transformative ability; generative conditions organize the environment of activation and reproduction; recursive asymmetry describes dynamic persistence; and economic manifestations provide historically situated institutional form. Together these elements supply GRE with a coherent analytical architecture for examining political economy across changing productive carriers, including mixed human–artificial systems and the universal-AI limit case that motivates the paper.

14 Research Synthesis

This section consolidates the paper's theoretical results and specifies the research implications of the Generative Relational Economics (GRE) framework. Its role is to connect the universal-AI thought experiment with the architectural categories developed in Sections 3–13, while separating synthesis from the shorter formal conclusion that follows the main analysis. The section has six objectives. Subsection 14.1 summarizes the structural result of the universal-AI test; Subsection 14.2 specifies the relation between productive-carrier variation and relational persistence; Subsection 14.3 identifies the political-economic categories that acquire broader scope under GRE; Subsection 14.4 develops comparative research designs suited to the framework; Subsection 14.5 outlines empirical operationalization; and Subsection 14.6 specifies the normative and institutional research programme. The discussion uses a synthesis-and-translation method: results established through the limit-case analysis are restated as general analytical propositions and then translated into researchable questions, variables, and institutional domains.

The universal-AI thought experiment has served throughout the paper as a controlled substitution test. Human labour and human productive agency are progressively replaced by artificial productive carriers

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while the analysis tracks which political-economic relations remain available. The experiment therefore provides a means of distinguishing relations that depend closely on a particular productive carrier from relations that can recur across different carriers. GRE develops from the second class of relations. Its research programme concerns the organization of generated outcomes, generative capacities, generative conditions, and the recursive processes through which these elements shape one another across time.

14.1 Structural Synthesis

This subsection integrates the principal results of the thought experiment. Its role is to identify the structures that remain analytically intelligible after extensive substitution of human productive agency by artificial productive agency. The synthesis proceeds across the sequence already developed in the paper: resource dependence, exchange, monetary coordination, accumulation, exploitation, power, rights, and justice.

The structural test begins with productive substitution. Section 5 shows that the identity of the productive carrier can change while dependence on energy, computation, materials, infrastructure, permissions, maintenance, and other enabling conditions remains. Section 6 then shows that heterogeneous requirements and scarce inputs can continue to generate transferable claims and generalized coordination mechanisms. Sections 7 and 8 extend the analysis to recursive accumulation and appropriation. Section 9 identifies power in the ability to shape feasible generative possibilities, and Sections 11 and 12 show that recognition, rights, access, participation, and intertemporal reproduction remain relevant within multi-agent economies.

The resulting pattern is one of relational persistence under carrier variation. Productive abundance can alter the material intensity and institutional visibility of familiar economic forms while leaving the underlying organization of access, dependence, claims, control, and reproduction available for renewed stabilization. The same observation applies to artificial agents themselves. Artificial agents can become productive carriers, exchange participants, holders of resource claims, operational investors, or governed entities, depending on the institutional architecture in which they are embedded.

Proposition 14.1 (Structural persistence under productive-carrier variation)**.** *Political-economic relations concerning access, dependence, transferable claims, recursive control, appropriation, and governance can remain analytically available when the principal productive carrier changes, provided that heterogeneous agents continue to depend on differentiated generative conditions.*

Proposition 14.1 summarizes the central result of the universal-AI test. Its significance lies in the separation of productive carriers from the relational architectures that organize generation. The proposition supports a broader analytical vocabulary capable of examining economies in which human and artificial agents occupy changing combinations of productive, allocative, governing, and dependent positions.

14.2 Carrier Comparison

This subsection clarifies the methodological significance of productive-carrier variation. Its role is to specify how GRE can compare economic systems across changes in labour composition, automation, embodiment, institutional form, and agent type without assuming that every category possesses identical meaning across those settings. The discussion distinguishes carrier-sensitive mechanisms from carrier-transcending relational structures.

Carrier-sensitive mechanisms depend materially on the properties of the productive entity. Human labour involves biological vulnerability, finite attention, embodied social reproduction, learning, mortality, and historically formed preferences. Artificial agency can involve computational scaling, replicability, modularity, dependence on technical infrastructure, externally governed update processes, or forms of persistence that differ from biological continuity. These differences affect production, bargaining, maintenance, coordination, and normative standing.

Relational persistence concerns a different level. A system can retain asymmetrical access, conditional permissions, infrastructure dependence, transferable claims, surplus appropriation, or concentrated

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governance across substantial changes in carrier properties. GRE therefore treats carrier type as one analytical dimension within a wider configuration of relations. The purpose is to preserve differences among agents while tracing comparable structures of generative dependence and control.

Definition 14.2 (Carrier-relational decomposition)**.** *Carrier-relational decomposition* is an analytical procedure that separates properties arising primarily from the characteristics of productive carriers from properties arising primarily from the relations governing access, coordination, appropriation, recognition, and reproduction.

Carrier-relational decomposition supports comparative analysis across historical and technological transitions. It can be used to distinguish, for example, a decline in human labour intensity from a decline in dependency, a rise in automated production from a broadening of generative access, or a change in ownership form from a change in effective control. The decomposition also helps identify cases in which similar visible outcomes emerge through different relational mechanisms.

Research Obligation 14.3 (Carrier-sensitive comparison)**.** Comparative applications of GRE should specify which observed effects plausibly depend on carrier-specific properties and which plausibly arise from relational structures that can persist across carrier variation.

Research Obligation 14.3 prevents the universal-AI limit case from becoming a flattening device. The thought experiment gains explanatory value when it reveals structural continuity while preserving the empirical and normative significance of differences among human, artificial, ecological, institutional, and mixed generative systems.

14.3 Category Extension

This subsection translates the structural results into a broader category system for political economy. Its role is to identify how established objects such as labour, money, capital, exploitation, power, and justice can be situated within the more general architecture of generated outcomes, generative capacities, and generative conditions. The objective is analytical extension and comparative interoperability across historical and technological settings.

Labour occupies a central place within GRE as one form of generative capacity whose reproduction depends on material, social, institutional, and relational conditions. Money can be analysed through generalized transferable claims that coordinate heterogeneous generative requirements. Capital can be examined through recursive conversion of present claims and control into expanded future generative capacity or governance. Exploitation can be studied through appropriation of outputs or capacities and through dependencies that weaken one agent's generative possibility while strengthening another position. Power concerns the capacity to modify generative spaces and the conditions under which those spaces evolve. Justice concerns outcomes, access, participation, return, inheritance, and the reproduction of acceptable generative conditions.

This category extension allows familiar political-economic forms to retain their historical specificity. GRE treats wages, firms, property, platforms, tokens, contracts, markets, public infrastructures, and artificial-agent protocols as economic manifestations whose functions can be analysed through the deeper relations they stabilize. The same manifestation can organize different relations across settings, and comparable relations can appear through different manifestations.

Proposition 14.4 (Category extension through generativity)**.** *Political-economic categories gain comparative scope when historically specific manifestations are analysed together with the capacities, conditions, claims, and recursive relations they organize.*

Proposition 14.4 establishes the theoretical role of GRE as an extension of political-economic analysis. The framework adds a common relational vocabulary for tracing economic organization across human, artificial, and mixed-agent systems while retaining the institutional detail required for concrete explanation.

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14.4 Comparative Design

This subsection specifies research designs suited to testing and refining GRE. Its role is to move the framework from a limit-case thought experiment toward comparative political-economic inquiry. Four complementary designs are especially useful: historical comparison, cross-institutional comparison, technological substitution analysis, and within-system relational comparison.

Historical comparison can examine how the same economic function has been organized through changing productive carriers and institutional forms. Mechanization, digitalization, platformization, and contemporary artificial-agent deployment provide settings in which labour composition, coordination mechanisms, ownership structures, and infrastructural dependencies can be compared across time. The relevant unit of comparison is the organization of generation and access around a specified function or domain.

Cross-institutional comparison can examine systems with similar technical capacities and different rules of access, ownership, governance, or recognition. Such designs can help distinguish technical capability from institutional organization. They are particularly useful for studying public and private infrastructures, open and closed technical ecosystems, cooperative and investor-owned organizational forms, or jurisdictions that assign different legal capacities to comparable agents and assets.

Technological substitution analysis can examine the reallocation of functions among human workers, software agents, embodied machines, and mixed teams. The method can track whether substitution changes final outcomes only, or also changes access rights, bargaining positions, resource dependencies, recognition, governance participation, and the reproduction of future capacity. Within-system relational comparison can then compare agents occupying different positions inside the same generative architecture, including upstream infrastructure controllers, downstream users, dependent artificial agents, human operators, and affected communities.

Research Obligation 14.5 (Relationally specified comparison)**.** GRE comparisons should specify the focal generative process, relevant agents, enabling conditions, access relations, and mechanisms linking present outcomes to future capacities or conditions.

Research Obligation 14.5 gives comparative work a common specification discipline. The purpose is to make relational claims traceable to observable institutions, resources, permissions, infrastructures, and sequences of interaction.

14.5 Operationalization

This subsection develops the empirical implications of the GRE architecture. Its role is to identify observable dimensions through which generated outcomes, generative capacities, generative conditions, recursive asymmetry, and recognized standing can be measured or approximated. The discussion treats operationalization as domain-specific because the relevant capacities and conditions differ across industries, scientific fields, digital infrastructures, ecological systems, and mixed-agent organizations.

Generated outcomes can be operationalized through domain-appropriate measures of output, income, access to goods and services, knowledge products, service provision, or realized opportunities. Generative capacities can be approximated through productive throughput, computational resources, technical capabilities, knowledge access, organizational competence, bargaining capacity, or the ability to initiate and sustain projects. Effective generative access requires additional measures of permissions, affordability, queue priority, interoperability, geographic availability, institutional eligibility, and reliability of access.

Generative conditions can be studied through infrastructure ownership, resource allocation rules, technical standards, legal rights, model or platform permissions, energy and material constraints, ecological states, educational systems, data access, maintenance structures, and governance arrangements. Recursive asymmetry can be operationalized longitudinally by tracing whether advantages in one period increase future control over these conditions. Recognized generative standing can be examined through

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contract capacity, account ownership, resource claims, refusal rights, modification authority, continuity protections, and participation in governance.

GRE also invites network and sequence-based empirical methods. Relational data can identify dependency chains among agents and infrastructures. Event histories can trace how claims are converted into capacity and how capacity is converted into future control. Comparative institutional analysis can identify points at which similar technical systems generate divergent access structures. Simulation and agent-based modelling can explore recursive dynamics under specified assumptions, while qualitative process tracing can reconstruct the institutional pathways through which those dynamics emerge in concrete settings.

Research Obligation 14.6 (Operational transparency)**.** Empirical applications of GRE should state how each selected indicator maps onto the relevant generative relation and should distinguish observed capability, effective access, formal entitlement, and realized use whenever those dimensions diverge.

Research Obligation 14.6 is especially important in artificial-agent settings. A model can possess technical capability while an operator lacks permission to deploy it, an agent can possess nominal access while facing binding resource constraints, and a legal entitlement can coexist with weak practical ability to exercise it. GRE treats these divergences as substantive political-economic phenomena.

14.6 Normative Programme

This subsection specifies the normative and institutional research programme opened by the framework. Its role is to connect the descriptive architecture of GRE with questions concerning access, governance participation, generativity return, rights, intertemporal inheritance, and the reproduction of shared generative conditions. The discussion preserves the distinction between structural diagnosis and normative evaluation while identifying the interfaces at which the two become jointly necessary.

The first research domain concerns access institutions. Future work can compare public provisioning, market allocation, cooperative access, commons-based infrastructures, subscription systems, tokenized allocation, and mixed arrangements according to the generative opportunities they make available and the dependencies they create. The second concerns governance institutions. Research can examine participation in decisions over model updates, platform rules, infrastructure investment, resource priorities, technical standards, ecological constraints, and termination or modification authority.

A third domain concerns generativity return. Institutions can be studied according to the extent to which they maintain human capabilities, knowledge systems, ecological sources, communities, technical infrastructures, and other generative conditions from which valuable outputs are drawn. A fourth concerns rights and standing in heterogeneous-agent systems. Here the relevant questions include the allocation of claims, obligations, refusal capacities, continuity protections, modification authority, liability, representation, and governance participation across human and artificial agents with different capabilities and normative statuses.

The fifth domain concerns temporal reproduction. The central research object is the trajectory produced by ordinary institutional operation. Arrangements that distribute outputs broadly in one period can still concentrate control over future conditions. Systems that expand artificial productive capacity can also generate new dependencies on energy, compute, data, ownership, or permission structures. Normative analysis therefore requires attention to the mechanisms through which present arrangements reproduce, revise, or destabilize future generative conditions.

Proposition 14.7 (Research priority of generative conditions)**.** *When present institutional arrangements materially shape future capacities, access, and governance positions, analysis of generative conditions provides information that cannot be recovered from outcome distributions alone.*

Proposition 14.7 supplies the final research implication of the paper's main analysis. GRE directs political economy toward the processes through which economic possibility is produced, allocated, reproduced, and governed. The universal-AI thought experiment makes these processes visible by loosening the historical association between human labour and productive agency. The resulting research

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programme extends beyond artificial intelligence. It applies wherever the organization of generation, access, dependence, recognition, and recursive control shapes the evolution of political-economic systems.

15 Conclusion

This conclusion closes the universal-AI thought experiment by restating its principal structural result, delimiting the scope of the argument, and locating the resulting claims within the broader Generative Relational Economics (GRE) research programme. Its role is narrower than the synthesis developed in Section 14. The present section does not reopen the detailed mechanisms already examined. It instead consolidates the paper around four concluding tasks. Subsection 15.1 states the result of productive-carrier substitution; Subsection 15.2 specifies the scope conditions and analytical boundaries of the thought experiment; Subsection 15.3 identifies the implications for GRE; and Subsection 15.4 closes with the political-economic significance of generative conditions. The method is synthetic: conclusions are restricted to claims supported by the substitution test and the relational architecture developed in the preceding sections.

15.1 Core Result

The central result concerns the distinction between productive carriers and political-economic relations. Extensive substitution of human productive agency by artificial agents can alter who performs cognitive, embodied, coordinative, and reproductive functions. Such substitution can reduce some forms of direct dependence on human labour and can expand the attainable volume and variety of generated outcomes. The same substitution leaves open the institutional organization of access, claims, ownership, resource allocation, governance, recognition, and the reproduction of enabling conditions.

The thought experiment therefore supports a carrier-relational distinction. Productive carriers concern the entities through which generative functions are performed. Generative relations concern the structured connections through which agents obtain outcomes, mobilize capacities, depend on conditions, appropriate surplus, acquire standing, and influence the formation of future possibilities. A change in productive carrier can transform one component of an economic system while leaving these relations available for persistence, recombination, or renewed concentration.

This structural persistence explains why money, capital-like accumulation, exploitation, and power remain analytically intelligible under the strong universal-AI assumption. Monetary forms can re-emerge where heterogeneous agents require scarce inputs and generalized transferable claims facilitate coordination. Capital-like circuits can arise where present claims or infrastructural control expand future command over generative capacity. Exploitation can arise through asymmetric appropriation of outputs or capacities and through dependence on controlled generative conditions. Power can operate through command, access control, resource allocation, modification of feasible generative spaces, and influence over the evolution of future conditions.

The thought experiment consequently places productive abundance and relational transformation on distinct analytical dimensions. Artificial abundance can relax important material constraints. Relational transformation concerns the institutional organization through which agents enter, use, shape, and reproduce the conditions of generation. Their interaction remains a substantive object of political economy.

15.2 Scope Limits

The argument is conditional on a deliberately strong limit case. Universal artificial generativity is used to suppress the explanatory role of human productive scarcity and thereby reveal relations that remain after a major change in productive carriers. The paper does not claim that such a system will emerge, that contemporary artificial intelligence already satisfies the assumed capacities, or that technological development follows a predetermined political-economic trajectory.

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The analysis also separates structural intelligibility from normative judgment. Demonstrating that artificial agents can occupy positions in exchange, accumulation, dependency, or governance does not settle their moral status, legal personhood, consciousness, or entitlement to rights. Section 11 therefore treated economic agency, legal recognition, and generative standing as separable dimensions. Future normative work must specify the grounds on which different agents receive claims, protections, obligations, representation, and participation rights.

A further boundary concerns empirical specification. GRE categories acquire explanatory value only when linked to identifiable resources, permissions, infrastructures, institutions, and sequences of interaction. Generative capacity cannot be inferred solely from nominal ownership, technical capability, or formal entitlement. Effective access, dependency, governance participation, and recursive effects require separate observation. The framework therefore provides an analytical architecture rather than a universal metric or a complete predictive model.

These scope conditions preserve the methodological role of the thought experiment. Its purpose is diagnostic. By varying the productive carrier while holding open the deeper organization of access and control, the analysis identifies which political-economic categories depend closely on historically specific forms and which categories remain available at a more general generative-relational level.

15.3 GRE Implications

The universal-AI test motivates GRE through three linked analytical layers. The first concerns generated outcomes and their distribution. The second concerns effective access to generative capacities. The third concerns the conditions through which those capacities are enabled, constrained, reproduced, and governed. Political-economic trajectories emerge through recursive interaction among these layers: present outcomes can alter future access, present access can reshape future capacity, and control over generative conditions can influence the distribution of possibilities across subsequent periods.

This architecture broadens the analytical treatment of familiar political-economic categories. Money can be studied through generalized claims on generated outputs and scarce generative inputs. Capital can be studied through the conversion of present control into expanded future generative control. Exploitation can be studied through asymmetric appropriation of outputs, capacities, and the benefits produced by controlled dependency. Power can be studied through the capacity to modify another agent's feasible generative space and the conditions under which that space evolves. Justice can be studied through distribution, access, governance participation, generativity return, and the intertemporal reproduction of conditions that sustain future agency.

GRE therefore shifts attention toward the organization of generation itself. The framework remains compatible with analysis of labour, commodities, property, markets, institutions, and distribution. Its additional contribution lies in tracing the relations through which these manifestations emerge and acquire durability. This orientation becomes especially useful when productive functions migrate across human and artificial agents, because the continuity of political-economic relations can then be studied without identifying those relations with a single historical carrier.

The resulting research programme extends well beyond artificial intelligence. Ecological systems, knowledge infrastructures, public institutions, educational systems, platforms, financial architectures, and scientific organizations all contain processes through which present arrangements shape future generative capacities and conditions. GRE provides a common vocabulary for comparing these processes while retaining the domain-specific institutions through which they operate.

15.4 Closing Synthesis

The universal-AI thought experiment began with a maximal substitution of productive agency. Its analytical value lies in the structures that survive that substitution. Once human labour is removed from its usual central position, the persistence of scarcity, claims, dependence, accumulation, appropriation, power, rights, and governance becomes easier to locate in the relations surrounding generative capacity and generative conditions.

This perspective reframes the significance of artificial abundance. Expanded productive capacity can enlarge the feasible space of social organization and can reduce forms of compulsory dependence associated with human labour scarcity. The institutional trajectory that follows remains contingent on the organization of access, control, standing, and governance. A society with extensive artificial production can therefore exhibit widely distributed generative access, concentrated infrastructural control, autonomous machine exchange, public provisioning, tokenized allocation, or combinations of these arrangements. Technical abundance defines possibilities; political-economic relations shape their realization.

The broader implication is that political economy retains a substantive object even under extreme productive automation. Its object increasingly concerns the relations through which agents gain access to generation, depend on shared conditions, convert present advantages into future control, and participate in shaping the infrastructures and institutions that structure subsequent possibilities. Generative Relational Economics names this analytical shift and offers a framework for studying political-economic systems in which the carriers of productive agency can change while relations of generation remain historically consequential.

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