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Why Development Is Rare: The Functional Architecture of Generative Development

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Why Development Is Rare: The Functional Architecture of Generative Development

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Abstract

Why is sustained, adaptive development so rare despite decades of institutional reform, industrial policy, macroeconomic stabilization and innovation strategies? This paper advances a structural explanation. It defines generative development as a process that is simultaneously endogenous, cumulative, structurally irreversible and transformatively adaptive, and argues that sustaining these four properties requires four irreducible causal functions: Collective Action (A), Production (P), Stabilization (S) and Redefinition of Goals (F).

The core claim is that the joint reproduction of these functions through a configuration of functional causal closure provides a necessary structural condition for sustaining development as a self-reinforcing and adaptive historical process. No dyadic or triadic subset of these functions is structurally sufficient to reproduce all four constitutive properties at once. Partial closures may generate growth, learning, institutional reform or strategic direction, but

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they remain intrinsically fragile and structurally exposed to stagnation, crisis or lock-in.

The paper offers a unified structural reinterpretation of institutional, evolutionary, developmental state and mission-oriented approaches as partial theories of distinct development functions. It also derives a typology of development regimes as systematic configurations of partial and full functional closure. A minimal dynamic representation presented in the Online Supplement illustrates the internal consistency of the argument. Overall, the paper reframes development as a problem of causal architecture rather than factor accumulation, with direct implications for development theory, industrial policy, institutional reform, mission-oriented strategies and comparative historical research.

Keywords: Generative development; Structural transformation; Industrial policy; Institutions and development; Mission-oriented policies

JEL Codes: O10; O25; P16; O33; O43; B52

1. Introduction — Why Development Is Rare

Why is sustained economic development so rare? Over the past seven decades, development economics and political economy have produced an extraordinary accumulation of knowledge on growth, industrialization, institutions, governance, macroeconomic management and innovation. Yet, long-run success stories remain exceptional, while reversals, premature deindustrialization and recurrent crises continue to characterize large parts of the Global South. From a historical perspective, the spatial and temporal concentration of development trajectories remains one of the most robust stylized facts of modern economic history (Maddison, 2001; Pomeranz, 2000; Broadberry et al., 2018).

This persistence of failure cannot be convincingly explained by ignorance of “what works”. Many of the factors commonly considered prerequisites of development—formal property rights, market institutions, openness to trade, industrial policy, human capital accumulation, innovation policies—are today far more widespread than in the past. Yet the diffusion of these factors has not produced a comparable diffusion of development outcomes. Countries often adopt broadly similar reform packages and policy strategies, but their long-term trajectories diverge sharply (Rodrik, 2004, 2007). This suggests that the problem does not primarily lie in missing ingredients as such, but in the architecture of their interaction through time.

A vast literature has identified key dimensions of development: capital accumulation and productivity growth (Solow, 1956; Maddison, 2001), industrialization and structural change (Kaldor, 1967; Amsden, 1989; Rodrik, 2004), institutions and governance (North, 1990; Acemoglu and Robinson, 2012), political settlements and state capacity (Khan, 2010; Pritchett et al., 2013; Kelsall et al., 2022), macroeconomic stability (Frenkel and Rapetti, 2012), and technological change and innovation (Perez, 2002; Mazzucato, 2013, 2021). Each of these strands has generated powerful insights. Yet none, taken in isolation, explains convincingly why development is so rare. Even

where several of these “fundamentals” appear to be present simultaneously, generative development often fails to emerge.

This paper advances a different hypothesis. It argues that sustained development is not the result of the accumulation of favorable factors, nor of their simple coexistence, but the emergent property of a specific causal architecture. We define generative development as a process that is simultaneously endogenous, cumulative, structurally irreversible and transformatively adaptive. These four properties are widely acknowledged in the literature as individually necessary for long-run development, yet they are rarely treated as a single integrated configuration. More importantly, no existing framework explains why these properties should systematically co-exist, and under which structural conditions they can be jointly sustained.

A central implication of this definition is that each of the four constitutive properties of generative development requires a distinct causal function. These properties do not arise from the same underlying mechanisms, and none of them can be derived from the others by implication. This is precisely why development is so rare.

Endogeneity requires a capacity for Collective Action (A). A development process can be internally driven only if a society is able to coordinate expectations, sustain political commitments, resolve distributional conflict and deliberately mobilize resources toward shared transformation. Markets, technologies and external integration cannot generate endogeneity on their own. Without A, change may occur, but it is externally induced—by commodity prices, foreign capital, donor agendas or geopolitical pressures—rather than politically and economically generated from within.

Cumulativity requires a distinct Production function (P). Collective coordination is not enough to generate self-reinforcing development dynamics unless it is translated into structurally transformative production, surplus generation, learning and dynamic increasing returns. Without P, collective action may be

intense and even visionary, but it remains economically sterile: ambitions do not accumulate into productive capabilities.

Irreversibility, in turn, requires a third function: Stabilization (S). Even when production and learning advance, development remains fragile unless their results are stabilized in durable institutions, property relations, macro-financial regimes, legal expectations and organizational routines. Without S, development remains reversible: crises, political turnover or financial shocks can dismantle in a few years what took decades to build.

Finally, adaptability cannot be derived from any combination of A, P and S alone. It requires a specific capacity for Redefinition of Goals (F): the ability to revise collective priorities, redirect investment and reorganize production in response to new technological paradigms, social demands and planetary constraints. Without F, even highly successful catch-up regimes tend toward rigidity, exhaustion and eventual lock-in.

Each function thus corresponds to one—and only one—of the four constitutive properties of generative development. Precisely because these properties are logically independent, no single function, and no dyadic or triadic subset of functions, can reproduce them all at once. Coordination without production yields activism without accumulation. Production without stabilization yields growth without durability. Stabilization without redefinition yields order without transformation. Redefinition without coordination yields ambition without capacity.

From this perspective, development is not the outcome of “many good things happening together”. It is the historically rare result of a specific functional architecture in which Collective Action (A), Production (P), Stabilization (S) and Redefinition of Goals (F) are not merely present, but causally closed, so that each function both conditions and is reproduced by the others.

The core theoretical claim of this paper is that only a full causal closure among these four functions can sustain development as a robust, self-reinforcing and adaptive historical process. No subset of the four is structurally sufficient to

jointly reproduce endogeneity, cumulativeness, irreversibility and adaptability over time. Partial closures may generate impressive episodes of growth, institutional reform or industrial upgrading, but they remain intrinsically fragile. They tend to accumulate internal tensions that eventually undermine their own foundations.

From this standpoint, the rarity of development reflects the exceptional difficulty of constructing and sustaining full functional closure across these dimensions. Countries may achieve growth without productive transformation, industrialization without political consolidation, stability without adaptability, or reform agendas without productive anchoring. All such configurations are structurally incomplete. They may persist for extended periods, but they remain exposed to stagnation, crisis or regression.

This logic also helps reinterpret current policy debates. Industrial policy without political consolidation often fails; institutional reform without productive transformation yields limited payoffs; macroeconomic stabilization without strategic direction induces stagnation; and visionary agendas without organizational capacity remain rhetorical. The framework proposed here does not replace existing theories; it reintegrates them within a unified causal architecture.

The analysis is not deterministic. The notion of functional causal closure captures a structural tendency rather than a mechanical law. Many countries experience prolonged phases of growth, institutional reform, or industrial deepening without full closure. Closure itself may remain partial, unstable or externally supported, and it can erode under political fragmentation, financialization, external dependency or strategic exhaustion. The claim advanced here is therefore both modest and demanding: without a sufficiently integrated functional architecture, sustained generative development is structurally unlikely.

Methodologically, the paper proceeds in three steps. First, it provides a functional definition of generative development and clarifies its four

constitutive properties (Section 2). Second, it derives the four irreducible development functions—A, P, S and F—and characterizes their causal roles (Section 3). Third, it develops the concept of functional causal closure and shows why partial closures are structurally unstable (Section 4). A minimal dynamic representation of this logic is presented in the Online Supplement, which formalizes the mutual dependence of the four functions and the instability of dyadic and triadic configurations. The model is not calibrated to data and is not intended for prediction; its role is to establish structural consistency and to clarify the logical architecture of the argument.

Building on this framework, the paper then derives a typology of development regimes based on systematic patterns of partial closure (Section 6), and discusses implications for development theory, policy and future research (Section 7). Section 8 concludes.

2. Generative Development: Definition and Core Properties

This section provides a functional definition of development and identifies the four core properties that distinguish generative development from growth, modernization or episodic reform success. The purpose is not to introduce new indicators of development, but to clarify the structural conditions under which development can reproduce itself through time.

2.1 Development Is Not Growth

In much of mainstream economics, development is treated as synonymous with increases in per capita income or productivity (Solow, 1956; Lucas, 1988; Romer, 1990). While this approach is analytically powerful, it abstracts from the structural, institutional and political transformations that distinguish sustained development from temporary expansion.

Empirical experience shows that growth can occur without durable transformation. Commodity booms, financial inflows or aid-driven expansions often generate impressive income gains but fail to produce persistent

upgrading of productive capabilities. Conversely, late industrialization episodes show that development involves not only faster growth, but durable changes in productive structures, institutions and collective expectations (Prebisch, 1950; Hirschman, 1958; Amsden, 1989). These contrasts motivate a more demanding definition of development as a process of structural reproduction, not a short-run performance outcome.

2.2 Definition of Generative Development

In this paper, development is defined as follows:

Generative development is a process through which a social system expands its productive, institutional and transformative capacities in a way that is simultaneously endogenous, cumulative, structurally irreversible and transformatively adaptive.

This definition shifts attention from static outcomes to dynamic reproduction. Development is not defined by any particular institutional form or policy mix, but by the system's capacity to continually regenerate the conditions of its own transformation.

2.3 Endogeneity

Endogeneity refers to the capacity of a development process to generate its driving forces internally. Development that is primarily driven by external demand, foreign capital, natural resource rents or aid flows may raise incomes but remains structurally vulnerable. By contrast, endogenous development rests on domestically embedded learning processes, production capabilities, fiscal capacity and political coordination (Myrdal, 1957; Kaldor, 1966; Cimoli et al., 2009).

Endogeneity does not imply autarky. It requires that international integration be mediated by domestic productive and political capacities. Where such mediation is weak, growth remains externally paced and highly sensitive to global commodity and financial cycles.

2.4 Cumulativity

Cumulativity refers to the presence of self-reinforcing feedback loops in which production, learning, investment and capability building strengthen each other through time. Learning-by-doing, increasing returns and technological interdependence generate dynamic paths in which today's expansion raises tomorrow's productive potential (Arrow, 1962; Kaldor, 1966; Dosi, 1982; Lundvall, 2010).

Where cumulativity is weak, growth depends on repeated external impulses or extraordinary policy interventions. Development remains extensive rather than intensive, and therefore structurally fragile.

2.5 Structural Irreversibility

Irreversibility concerns the durability of transformation. Development is irreversible when productive capabilities, institutions and social relations become embedded in material structures, organizational routines and legal frameworks that are costly to undo.

Temporary industrialization, reversible institutional reforms and crisis-prone growth episodes fail this test. By contrast, irreversible development reshapes the feasible set of future options through path-dependent dynamics (David, 1985; Arthur, 1994; Pierson, 2000). Without irreversibility, development remains exposed to recurrent regression.

2.6 Transformative Adaptability

Adaptability refers to the capacity of a development process to redirect its trajectory in response to new technologies, social demands and environmental constraints. A system may achieve endogeneity, cumulativity and irreversibility for a time, yet still fail to adapt when external conditions shift.

Historically, major development reversals often reflect not a lack of growth, but the inability of dominant production systems and political coalitions to reorganize under changing technological paradigms or global constraints

(Perez, 2002; Mazzucato, 2021). Adaptability therefore distinguishes development from mere path dependence.

2.7 Logical Independence of the Four Properties

A crucial analytical point is that the four properties of generative development are logically independent. None implies the others. Endogeneity without cumulativeness yields localized progress without systemic momentum. Cumulativeness without irreversibility yields growth without durability. Irreversibility without adaptability yields rigid lock-in. Adaptability without endogeneity yields continuous strategic shifts without productive anchoring.

These partial configurations are empirically common and structurally unstable.

2.8 Development as a Problem of Causal Architecture

The joint presence of endogeneity, cumulativeness, irreversibility and adaptability defines generative development. This already implies that development cannot be understood as the additive result of favorable factors. Instead, it is an emergent property of a specific causal architecture.

The next section therefore turns from properties to functions. It introduces the four irreducible development functions—Collective Action (A), Production (P), Stabilization (S) and Redefinition of Goals (F)—that we argue are jointly necessary to sustain generative development through time.

3. The Four Development Functions: Collective Action (A), Production (P), Stabilization (S) and Redefinition of Goals (F)

Section 2 has defined generative development as the joint presence of endogeneity, cumulativeness, structural irreversibility and transformative adaptability. The question addressed in this section is the following: which minimal set of social functions must a system possess in order for these four properties to be jointly sustained over time?

The argument advanced here is functional rather than institutional. We do not start from pre-defined entities such as the state, the market, firms or culture. Instead, we identify the causal roles that must be continuously performed if generative development is to remain viable. Different historical configurations may realize these same functions through different institutional arrangements. The claim is not that the four functions identified below exhaust the complexity of development, but that they constitute a minimal and irreducible functional domain. Each function is necessary, and none can be substituted for by the others.

3.1 From Properties to Functions

Each constitutive property of generative development identified in Section 2 requires a corresponding systemic function that makes its reproduction possible:

Endogeneity requires a function that enables coordinated internal action → Collective Action (A).

Cumulativity requires a function that generates surplus, learning and increasing returns → Production (P).

Irreversibility requires a function that stabilizes outcomes in durable forms → Stabilization (S).

Adaptability requires a function that enables deliberate redirection of priorities → Redefinition of Goals (F).

These correspondences are not definitional but causal. Each function performs a role that no other function can replicate. The four functions therefore represent logically distinct conditions for the reproduction of the four properties of development.

3.2 Collective Action (A)

Definition. Collective Action (A) refers to the capacity of a society to coordinate behavior, sustain collective commitments through time, mobilize resources for shared objectives and manage distributional conflict in a non-destructive way.

This function includes, but is not reducible to, the state. It encompasses political settlements, bureaucratic capacity, the credibility of enforcement, the density of social and economic organizations, and the institutionalized ability to resolve conflicts over rents, taxation, investment priorities and social protection.

The centrality of A is emphasized across several strands of the literature. The theory of collective action highlights the structural difficulty of producing public goods and overcoming free-riding (Olson, 1965). Institutional economics stresses the role of credible commitment and enforcement (North, 1990; Greif, 2006). Political economy approaches to development emphasize state capacity, political settlements and elite coordination (Khan, 2010; Pritchett et al., 2013; Kelsall et al., 2022). The developmental state literature documents how specific forms of disciplined coordination between state and firms sustained late industrialization (Amsden, 1989; Wade, 1990; Evans, 1995).

Causal role. A is the condition of endogeneity. Without a functioning capacity for collective action, development dynamics cannot be internally generated. Change may still occur, but it will be externally induced—by commodity booms, foreign capital inflows or imposed reforms—rather than deliberately produced from within. In this sense, A is what turns a society from a passive recipient of shocks into a potential subject of transformation.

3.3 Production (P)

Definition. Production (P) refers to the systemic capacity to generate surplus, learning and dynamic increasing returns through structurally transformative productive activity.

P is not equivalent to the existence of markets or firms as such, nor to the mere expansion of output. It refers to the capability to upgrade production

structures, accumulate technological and organizational knowledge, and generate sustained productivity growth. The literature on industrialization, technological change and systems of innovation has documented how production capabilities are built through learning-by-doing, learning-by-using and learning-by-interacting (Arrow, 1962; Kaldor, 1966; Dosi, 1988; Freeman and Soete, 1997; Cimoli et al., 2009).

Causal role. P is the condition of cumulativity. Only when production generates persistent learning and surplus can development become self-reinforcing. Without P, collective action may support redistribution, stability or even ambitious plans, but it cannot generate the material basis for dynamic increasing returns. Visions remain disconnected from productive capabilities.

3.4 Stabilization (S)

Definition. Stabilization (S) refers to the capacity to consolidate economic and social relations in durable institutional, legal and macro-financial forms. This function includes macroeconomic stabilization, protection of property and contractual rights, fiscal capacity, financial regulation, and the routinization of key organizational practices.

The importance of S is emphasized in the literature on macroeconomic instability in developing economies (Frenkel and Rapetti, 2012), on institutional credibility (North, 1990), and on path dependence and increasing returns (Arthur, 1994; Pierson, 2000).

Causal role. S is the condition of irreversibility. Even when production and learning advance, development remains fragile unless its results are embedded in institutions, infrastructures, fiscal systems and expectations that stabilize intertemporal commitments. Without S, progress remains reversible. Financial crises, political turnover or external shocks can rapidly dismantle accumulated capabilities.

3.5 Redefinition of Goals (F)

Definition. Redefinition of Goals (F) refers to the capacity of a society to deliberately revise development priorities, redirect investment, and reorganize production in response to new technological, social and environmental constraints.

Unlike much of the traditional literature, which treats development objectives as exogenously given or politically residual, this paper conceptualizes F as a core systemic function. It captures a society's ability to articulate new missions, abandon obsolete priorities and coordinate expectations around new long-term horizons. Recent work on technological paradigms and mission-oriented innovation highlights the centrality of this function (Perez, 2002; Mazzucato, 2013, 2021; UNCTAD, 2022).

Causal role. F is the condition of adaptability. Without it, even highly successful catch-up regimes risk becoming structurally rigid. Past success becomes a source of lock-in rather than a platform for renewal. F enables systems to confront technological disruptions, social contestation and planetary boundaries without relying on mere crisis-driven adjustment.

3.6 Irreducibility and Non-Substitutability of the Four Functions

Each of the four functions performs a distinct causal role. None of them can be derived from the others, and none can substitute for the others.

A without P yields coordination without accumulation.

P without S yields growth without durability.

S without F yields stability without transformation.

F without A yields vision without capacity.

These configurations are not theoretical curiosities. They correspond to empirically recurrent development pathologies: activist but economically sterile regimes; growth episodes repeatedly undone by crises; stable yet stagnant political economies; visionary development agendas that never become operational.

The key implication is that no dyadic or triadic configuration of functions is structurally sufficient to reproduce the full set of properties that define generative development.

3.7 Transition to Functional Causal Closure

If endogeneity, cumulativeness, irreversibility and adaptability require, respectively, A, P, S and F, then sustained development cannot depend on the presence of these functions in isolation. What matters is how these functions are causally connected and mutually reproduced through time.

The next section develops this point formally by introducing the concept of functional causal closure. It shows why only a configuration in which A, P, S and F form a closed causal loop—in which each function is both a condition and a result of the others—can sustain generative development as a robust historical process.

4. Functional Causal Closure and the Architecture of Generative Development

Sections 2 and 3 have established two core results. First, generative development requires the joint presence of four logically independent properties: endogeneity, cumulativeness, structural irreversibility and transformative adaptability. Second, each of these properties requires a distinct and irreducible causal function: Collective Action (A), Production (P), Stabilization (S) and Redefinition of Goals (F). The central question addressed in this section is therefore the following: under which structural conditions can these four functions be jointly sustained through time so as to reproduce all four properties of development?

The answer advanced here is that this joint reproduction requires a specific form of functional causal closure. Development becomes generative only when A, P, S and F are not merely present, but causally connected in a closed loop, such that each function both conditions and is reproduced by the others. No

partial configuration of functions is structurally sufficient to sustain generative development over time.

4.1 What Is Functional Causal Closure?

By functional causal closure we mean a configuration in which the operation of each function is a necessary condition for the reproduction of the others. In a closed architecture, A sustains P, P sustains S, S sustains F, and F in turn sustains A, completing a circuit of mutual reproduction.

This notion of closure is not borrowed from biology or systems theory by analogy. It is introduced here as a purely structural concept: closure refers to the minimal architecture through which a set of distinct causal functions becomes capable of reproducing itself through time. Without closure, functions may coexist, but they do not form a self-sustaining regime.

In an open configuration, one or more functions depend systematically on exogenous supports—external demand, geopolitical protection, financial inflows, inherited institutions, or temporary political coalitions. As a result, the system may display episodes of growth or reform, but it lacks the internal mechanisms required to regenerate the full set of development conditions endogenously.

4.2 Why Partial Closures Are Structurally Insufficient

A key implication of the argument developed so far is that no dyadic or triadic subset of A, P, S and F can reproduce all four properties of generative development simultaneously. This is not an empirical generalization but a structural result that follows from the logical independence of the four properties.

Consider briefly the main families of partial closure:

A–P without S and F. Coordination and production may generate growth and learning, but without stabilization this trajectory remains fragile, and without

redefinition of goals it tends toward exhaustion and lock-in. Many early industrialization episodes fall into this category.

P–S without A and F. Production and stabilization may sustain enclaves of capital accumulation, but without collective action they lack political endogeneity, and without goal redefinition they remain rigid and socially contested.

A–S without P and F. Political coordination and institutional stability may generate order, but without productive transformation growth remains limited, and without strategic redirection the system becomes conservative and stagnant.

A–P–S without F. This configuration corresponds to successful catch-up regimes that accumulate capabilities and stabilize institutions, but eventually encounter structural rigidities when technological, social or environmental constraints shift.

A–P–F without S, P–S–F without A, and other triadic combinations all exhibit symmetric limitations: one of the four constitutive properties of generative development remains structurally unsupported.

The conclusion is that partial closure always implies a specific form of structural fragility. Growth may occur, institutions may consolidate, capabilities may accumulate, and strategies may be articulated, but one or more of the four properties—endogeneity, cumulativeness, irreversibility, adaptability—remains only weakly reproduced. This is the structural origin of development traps, growth reversals and recurrent crises.

4.3 Full Closure as a Structural Condition for Generativity

In a configuration of full functional causal closure, by contrast, the four functions mutually reproduce each other:

Collective Action (A) sustains Production (P) by coordinating investment, resolving distributional conflict and enforcing strategic priorities.

Production (P) sustains Stabilization (S) by generating surplus, fiscal capacity and organizational routines.

Stabilization (S) sustains Redefinition of Goals (F) by providing the institutional and macro-financial conditions under which long-term strategic reorientation is feasible.

Redefinition of Goals (F) sustains Collective Action (A) by rearticulating shared priorities, reorganizing coalitions and renewing political legitimacy.

Only in this configuration can the four constitutive properties of generative development be jointly reproduced through time. Endogeneity emerges because coordination is internally regenerated. Cumulativity emerges because production feeds back into its own expansion. Irreversibility emerges because outcomes are stabilized in durable forms. Adaptability emerges because strategic redirection is institutionally supported rather than crisis-driven.

From this perspective, generative development is not the outcome of “good performance” along multiple dimensions. It is the outcome of a specific recursive architecture in which the conditions of development are themselves endogenously reproduced.

4.4 Functional Closure as a Tendency, Not a Mechanical Law

The concept of functional causal closure does not imply determinism. It does not state that whenever A, P, S and F are present, development will necessarily follow, nor that development trajectories cannot regress. Closure should instead be understood as a structural tendency: a configuration that makes the joint reproduction of the four properties possible in principle.

Closure can be incomplete, unstable or temporarily enforced by external conditions. It can emerge gradually and unevenly. It can also erode under political fragmentation, financialization, external dependency or strategic exhaustion. In this sense, the framework is fully consistent with the historical observation that even highly successful development regimes can stagnate or regress.

The claim is therefore neither that closure is permanent, nor that it is sufficient to guarantee success. The claim is more precise: without closure, sustained generative development is structurally unlikely.

4.5 A Minimal Dynamic Representation

To clarify the internal consistency of this argument, a minimal dynamic representation of the A–P–S–F system is presented in the Online Supplement. The purpose of this formalization is not empirical calibration or prediction. It serves instead as a consistency check: it shows that a system of mutually interdependent functions can, under plausible conditions, generate multiple dynamic regimes—development traps, partial-development regimes and fully generative regimes—depending on the presence or absence of full closure.

The model also illustrates how partial closures can generate temporary growth followed by stagnation or collapse, and why only full closure produces self-reinforcing and adaptive trajectories. The use of a simple evolutionary dynamic representation allows the argument to remain transparent and avoids reliance on strong parametric assumptions (see Online Supplement, Section A).

4.6 Implications for the Interpretation of Development Failures

Viewed through the lens of functional causal closure, many recurrent development failures can be reinterpreted as the systematic consequences of specific missing links in the A–P–S–F architecture. Development traps do not primarily reflect the absence of particular policies or institutions, but the persistent disconnection between functions that prevents the joint reproduction of endogeneity, cumulativeness, irreversibility and adaptability.

This perspective helps explain why similar policy packages produce divergent outcomes across countries and periods. It also clarifies why improvements along one or two dimensions—better institutions, stronger industrial policy, increased innovation effort—often fail to translate into sustained development when they are not embedded in a closed functional architecture.

4.7 Transition to Development Regimes

If development outcomes depend on how A, P, S and F are connected, then different historical trajectories can be interpreted as systematic patterns of partial or complete closure. Fully generative regimes, catch-up regimes, stagnant regimes, extractive regimes and fragmented reform regimes correspond to structurally distinct ways in which the four functions fail—or partially succeed—to close.

The next section builds on this logic to derive a typology of development regimes as alternative empirical realizations of partial or full functional closure.

5. Development Theories as Partial Theories of the Functional Architecture

The A–P–S–F framework allows the main traditions of development theory to be reinterpreted from a unified structural perspective. Rather than being mutually exclusive, institutional, evolutionary, developmental state and mission-oriented approaches can be understood as partial theories of specific development functions. Each captures a necessary dimension of generative development, but none provides a theory of development as a closed causal process.

This reinterpretation clarifies both the explanatory power and the systematic limits of existing approaches.

5.1 Institutions and the Stabilization Function (S)

Institutional theories emphasize property rights, contract enforcement and credibility as foundations of long-run development (North, 1990; Acemoglu and Robinson, 2012). In functional terms, they provide a theory of Stabilization (S), explaining how durable expectations and macro-institutional order support irreversibility.

However, these approaches often treat Collective Action (A) as exogenous and Production (P) as an automatic response to institutional quality. From the

standpoint of functional closure, this explains why institutional reform alone frequently fails to trigger sustained development.

5.2 Innovation, Learning and the Production Function (P)

Evolutionary and innovation-based theories place learning, technological change and capability accumulation at the center of development (Nelson and Winter, 1982; Dosi, 1988; Freeman and Soete, 1997; Cimoli et al., 2009). These contributions offer the most systematic account of the Production function (P) as the driver of cumulativeness.

Yet they typically under-theorize the political coordination required to sustain learning (A) and the institutional and macro-financial conditions that stabilize its results (S). This helps explain why productive upgrading is often vulnerable to crises and liberalization shocks.

5.3 Political Economy and the Collective Action Function (A)

The developmental state and political settlements literature focuses on state capacity, elite coordination and the management of distributional conflict (Amsden, 1989; Wade, 1990; Evans, 1995; Khan, 2010). These approaches provide a theory of Collective Action (A) as the foundation of endogeneity.

However, they often treat production and stabilization as derivative of political capacity, and development goals as given. As a result, they explain the emergence of coordination but less clearly the conditions under which it becomes economically cumulative and strategically adaptive.

5.4 Mission-Oriented Approaches and the Redefinition of Goals Function (F)

Mission-oriented and transformative development approaches explicitly emphasize directionality and strategic reorientation (Perez, 2002; Mazzucato, 2013, 2021; UNCTAD, 2022). They provide a theory of the Redefinition of Goals function (F) as the institutionalization of adaptability.

From a functional closure perspective, however, these approaches often presuppose the prior existence of robust A, P and S. Where these functions are weak, strategic missions tend to remain rhetorical rather than operative.

5.5 Why Partial Theories Do Not Add Up Automatically

Taken together, these traditions span the full functional domain of generative development. Yet their coexistence does not imply that their mechanisms automatically coalesce in reality. A country may display strong institutions (S), dynamic innovation (P), effective state coordination (A), or ambitious missions (F) without achieving sustained development.

This is because development depends not on the simultaneous presence of multiple favorable mechanisms, but on their systemic integration through functional closure. Without closure:

institutional reform (S) may fail to ignite production (P);

innovation (P) may be derailed by macro instability (S);

political coordination (A) may be exhausted without productive rents (P);

strategic missions (F) may collapse without coordination (A) or stabilization (S).

5.6 A Structural Grammar of Development Theory

The contribution of this paper is not to replace existing theories, but to provide a structural grammar that situates them within a single causal architecture. Each major tradition emerges as a theory of a necessary but insufficient function.

This explains both:

their high explanatory power in specific contexts, and

their repeated failure to generalize across time and space.

By shifting attention from isolated determinants to their structural interdependence, the A–P–S–F framework makes it possible to integrate success and failure within a unified analytical language.

5.7 Transition to Development Regimes

If development theories are best understood as partial theories of the functional architecture, then observed development paths can be interpreted as empirical realizations of partial or full closure among A, P, S and F. The next section derives a typology of development regimes as systematic configurations of these closures.

6. Development Regimes as Configurations of Partial and Full Functional Closure

If sustained development depends on how the four functions—Collective Action (A), Production (P), Stabilization (S) and Redefinition of Goals (F)—are causally connected, observed development trajectories can be interpreted as systematic configurations of partial or full functional closure. Development regimes are therefore defined not by income levels or policy instruments, but by which functional links are structurally connected and which remain persistently missing.

This section derives a typology of development regimes as analytically distinct realizations of partial and full closure. The purpose is not empirical classification, but the identification of recurrent structural patterns and vulnerabilities.

6.1 Fully Generative Development Regimes (A–P–S–F)

Fully generative regimes are characterized by a closed causal configuration among all four functions. Collective Action sustains Production; Production sustains Stabilization; Stabilization sustains Redefinition of Goals; and

Redefinition of Goals renews Collective Action. In these regimes, endogeneity, cumulativeness, irreversibility and adaptability are jointly reproduced.

Historically, this configuration corresponds to the rare cases of sustained long-run development in which productive upgrading, institutional consolidation, political coordination and strategic direction mutually reinforce each other. These regimes are not crisis-free, but they display a strong capacity for endogenous recovery and directional adjustment.

6.2 Catch-Up Developmental Regimes (A–P–S without F)

Catch-up regimes display a strong closure among A, P and S, but a weak Redefinition of Goals (F). Political coordination, production and stabilization generate rapid industrialization, learning and institutional consolidation. Endogeneity, cumulativeness and irreversibility are achieved, often with remarkable speed.

However, strategic direction tends to remain narrowly focused on imitation and export competitiveness. When technological paradigms, social demands or environmental constraints shift, the absence of a strong F function generates rigidity. This helps explain the emergence of middle-income traps and strategic exhaustion in some successful late industrializers.

6.3 Growth without Durability Regimes (A–P without S)

These regimes display partial closure between Collective Action and Production, without effective Stabilization. Political coordination and production generate growth and learning, but weak macro-financial and institutional consolidation make outcomes structurally reversible.

Development takes the form of recurrent cycles of expansion and crisis. Cumulativeness is intermittently achieved, but irreversibility remains weak. Many financially driven growth episodes and precarious industrialization experiences fall into this category.

6.4 Stability without Transformation Regimes (A–S without P and F)

In these regimes, Collective Action and Stabilization are connected, while Production and Redefinition of Goals remain weak. Political coordination and institutional consolidation generate order, macro stability and predictable expectations. However, productive transformation is limited and long-term strategic direction is absent.

These configurations tend toward institutional conservatism and gradual stagnation, as global technological and demand conditions evolve.

6.5 Extractive and Rent-Based Regimes (P–S without A and F)

In extractive and rent-based regimes, Production (often resource extraction) and Stabilization are partially connected, while Collective Action and Redefinition of Goals are weak. Surplus is generated and sometimes stabilized through fiscal and financial institutions, but accumulation remains driven by external rents.

Endogeneity and adaptability remain structurally weak, explaining the persistence of resource dependence, limited diversification and high vulnerability to external shocks.

6.6 Fragmented Reform Regimes (F without A, P and S)

These regimes are characterized by a weak and isolated Redefinition of Goals (F), in the absence of robust A, P and S. They display ambitious development narratives—digitalization, green growth, social inclusion—but lack the coordination, productive base and stabilization required for implementation.

Adaptability is discursive rather than material, and development remains performative rather than cumulative.

6.7 Hybrid Regimes and Structural Vulnerabilities

Between these ideal types, many countries display hybrid configurations in which some functional links are intermittently connected while others remain persistently fragile. These asymmetries explain why development trajectories often appear internally contradictory: growth alongside institutional fragility,

political stability alongside productive stagnation, or visionary agendas alongside weak implementation.

Each regime is characterized by a specific structural vulnerability:

Catch-up regimes tend toward rigidity and exhaustion.

Growth-without-durability regimes tend toward crisis and reversal.

Stability-without-transformation regimes tend toward stagnation.

Extractive regimes tend toward dependency and volatility.

Fragmented reform regimes tend toward performative policy cycles.

These vulnerabilities are not contingent policy errors, but the systematic consequences of incomplete functional closure.

6.8 Transition to Implications

Interpreting development regimes as configurations of partial and full functional closure shifts the analytical focus from “which policies are adopted” to how the core development functions are connected. It also implies that regime transitions—successful or failed—can be understood as processes of closing or breaking specific functional links within the A–P–S–F architecture.

The next section discusses the implications of this framework for development theory, policy design and future research.

7. Implications for Development Theory, Policy and Research

The framework developed in this paper has implications for three interconnected domains: development theory, development policy and future research agendas. By shifting the focus from individual determinants to the functional causal architecture of development, it reframes several long-standing debates and clarifies why many well-established policy prescriptions produce uneven or fragile outcomes.

7.1 Implications for Development Theory

For development theory, the A–P–S–F framework implies a change in the unit of explanation. Development should no longer be conceptualized primarily as the outcome of specific variables—institutions, human capital, openness, innovation—but as the outcome of a specific configuration of interdependent functions.

This perspective helps reconcile two persistent empirical puzzles:

Why partial theories often work well in some contexts but fail in others. Institutional theories explain irreversibility but not cumulativity. Innovation theories explain cumulativity but not irreversibility. Political economy theories explain endogeneity but not necessarily adaptability. Mission-oriented theories explain adaptability but often presuppose the other three. Each is powerful precisely because it captures one essential function—but none is generative on its own.

Why development trajectories are historically unstable and path-dependent at the same time. The framework shows that stability and fragility coexist because partial closures generate self-reinforcing dynamics along some dimensions while leaving others structurally unsupported. Development paths are therefore neither fully open nor fully locked-in, but conditionally stable.

More broadly, the A–P–S–F architecture provides a structural grammar for organizing middle-range development theories within a single integrative framework. It does not replace these theories; it explains why they must be combined through closure rather than juxtaposed through aggregation.

7.2 Implications for Industrial Policy

Industrial policy is one of the domains where the limits of partial approaches are most visible. From the standpoint of the present framework, industrial policy cannot be reduced to a set of sectoral incentives or to the correction of market failures within the Production function alone.

Without Collective Action (A), industrial policy lacks political coordination and becomes vulnerable to capture, fragmentation or policy incoherence.

Without Stabilization (S), industrial policy cannot anchor expectations, finance long-term investment or protect learning processes from macro-financial volatility.

Without Redefinition of Goals (F), industrial policy remains backward-looking, focused on scale expansion and imitation rather than on strategic redirection under changing technological and environmental constraints.

Successful industrial policy therefore presupposes not only productive targeting, but the simultaneous construction of political coordination, financial-institutional stabilization and strategic directionality. This helps explain why similar industrial policy instruments generate radically different outcomes across countries.

7.3 Implications for Institutional Reform

Institutional reform is often treated as a foundational precondition for development. From the perspective of functional closure, institutional change should instead be understood as one moment within a broader causal architecture.

Reforms that strengthen property rights, regulatory capacity or fiscal institutions contribute primarily to Stabilization (S). However, without being embedded in closures with A, P and F, such reforms tend to generate:

formal stability without productive transformation,

improved rankings without cumulative capability building,

institutional modernization without endogenous development.

The framework thus helps explain why highly ambitious institutional reform agendas often yield limited developmental payoffs when they are not

connected to productive transformation, political coordination and strategic reorientation.

7.4 Implications for Mission-Oriented and Transformative Policies

Mission-oriented policies, green industrial strategies and digital transformation agendas place the Redefinition of Goals (F) at the center of policy discourse. The A–P–S–F framework clarifies both the novelty and the limits of this turn.

On the one hand, these approaches correctly identify that long-term development cannot rely exclusively on spontaneous structural change or on backward-looking comparative advantages. Strategic directionality has become a core developmental issue under conditions of climate transition, digital disruption and geopolitical fragmentation.

On the other hand, the framework highlights that F cannot operate in isolation. Ambitious missions require:

A, to mobilize political coalitions and sustain distributional compromise;

P, to translate missions into productive and technological capabilities;

S, to finance, stabilize and institutionalize long-term transformation.

Where these conditions are absent, mission-oriented strategies risk degenerating into discursive policy cycles rather than material transformation.

7.5 Implications for Development Policy Design

A direct implication of the functional architecture approach is that development policy cannot be modularized into independent toolkits. Policies targeting individual functions must be evaluated not only in terms of their direct effects, but also in terms of whether and how they contribute to closing the A–P–S–F loop.

From this perspective, the central policy question shifts from:

“Which policies should be adopted?”

to:

“Which functional links are currently missing or fragile, and how can they be structurally reinforced?”

This implies that policy coherence should be assessed architecturally rather than instrumentally. The same instrument may strengthen closure in one context and weaken it in another, depending on how it reshapes the relations among A, P, S and F.

7.6 Implications for Comparative and Historical Research

For comparative and historical research, the framework suggests a shift from indicator-based classifications to architecture-based interpretations of development trajectories. Rather than grouping countries by income levels, growth rates or institutional scores, the A–P–S–F perspective encourages the analysis of:

which functions are structurally connected,

which links are missing or unstable,

how closures are gradually constructed or eroded over time.

This also implies that regime transitions—both successful and failed—should be interpreted as processes of functional reconfiguration, not merely as changes in policy regimes or political leadership.

7.7 Implications for Modeling and Formal Analysis

Finally, the framework opens new directions for formal modeling. Instead of representing development through reduced-form growth equations or representative-agent dynamics, future models can explicitly represent multiple interacting functions and their closure properties.

The minimal dynamic representation presented in the Online Supplement illustrates one possible approach. It shows how different patterns of partial

and full closure generate distinct dynamic regimes. More elaborate agent-based, network or evolutionary models could further explore how closure emerges, stabilizes or collapses under different structural conditions.

7.8 Limits and Scope of the Framework

The A-P-S-F framework does not claim to explain every aspect of development, nor does it offer a universal policy recipe. It is a theory of structural possibility conditions, not a predictive model. Its purpose is to clarify why development is historically rare, why partial successes are common, and why reversals are recurrent.

Its validity should therefore be assessed in terms of:

internal logical coherence,

capacity to reinterpret existing empirical regularities,

and heuristic power in guiding future research.

7.9 Transition to the Conclusion

If generative development depends on the rare and unstable closure of four irreducible functions, then development traps, regime fragilities and recurrent failures appear as structural outcomes rather than mere policy errors. The concluding section draws together the main theoretical results of the paper and summarizes their broader implications.

8. Concluding Remarks

This paper has addressed a deceptively simple but theoretically demanding question: why is sustained, adaptive development so rare, despite the wide diffusion of growth-enhancing policies, institutional reforms and innovation strategies? The answer advanced here is structural rather than factor-based. Development fails to emerge or to persist not primarily because specific

ingredients are missing, but because the functional architecture required to reproduce development through time remains incomplete.

We have defined generative development as a process that is simultaneously endogenous, cumulative, structurally irreversible and transformatively adaptive. These four properties are logically independent and cannot be reduced to one another. Their joint reproduction therefore requires a minimal set of four irreducible causal functions: Collective Action (A), Production (P), Stabilization (S) and Redefinition of Goals (F). Each function is necessary, and none is sufficient on its own.

The central theoretical result of the paper is that only a configuration of full functional causal closure among A, P, S and F can sustain generative development as a self-reinforcing and adaptive historical process. No dyadic or triadic subset of these functions can reproduce all four properties simultaneously. Partial closures may generate growth, learning, institutional reform or strategic visions, but they remain structurally fragile. Their vulnerabilities reflect not contingent policy mistakes, but systematic missing links in the functional architecture of development.

This perspective allows the main traditions of development theory to be reinterpreted within a unified framework. Institutional, evolutionary, political economy and mission-oriented approaches emerge as partial theories of distinct development functions. Their empirical power is thereby explained, as are their repeated failures to generalize across contexts. Development does not result from the simple aggregation of these mechanisms. It requires their systemic integration through closure.

The framework also provides a structural basis for interpreting development regimes as distinct configurations of partial and full functional closure. Fully generative regimes appear as historically rare outcomes of sustained closure. Catch-up regimes, growth-without-durability regimes, stability-without-transformation regimes, extractive regimes and fragmented reform regimes

emerge as systematic variants of incomplete closure, each characterized by specific strengths and predictable structural vulnerabilities.

Several implications follow.

First, for theory, the paper suggests that development should be explained at the level of interdependent functions rather than isolated variables. The proper object of analysis is not institutions, innovation or state capacity taken separately, but the architecture through which their causal roles are connected.

Second, for policy, the results imply that development strategies cannot be modularized into independent reform agendas. Industrial policy, institutional reform and mission-oriented strategies become mutually dependent, not additively complementary. The central policy challenge shifts from selecting instruments to constructing and maintaining functional closure under conditions of political conflict, macro-financial volatility and global technological change.

Third, for comparative and historical research, the framework suggests a move from indicator-based country classifications to architecture-based interpretations of development trajectories, centered on which functional links are present, missing or unstable at different points in time.

The analysis is intentionally non-deterministic. Functional causal closure is not a mechanical law, nor a guarantee of success. It is a structural possibility condition. Closure can emerge gradually, remain partial, erode or collapse. Even highly successful development regimes can stagnate or regress when closure weakens—through financialization, political fragmentation, external dependency or strategic exhaustion. The claim advanced here is therefore both modest and demanding: without closure, sustained generative development is structurally unlikely.

Two limitations of the present contribution should be noted. First, the framework operates at a high level of abstraction. It does not specify which

concrete institutional forms, political coalitions or policy instruments realize A, P, S and F in particular historical contexts. These are matters for comparative institutional and political economy analysis. Second, while the minimal dynamic representation presented in the Online Supplement establishes internal consistency, much work remains to explore empirically how closures are constructed, stabilized and broken across different development experiences.

Future research can proceed along several directions. Empirically, the framework invites comparative studies of how functional closures have been built or disrupted in specific countries and periods. Methodologically, it opens space for agent-based, network and evolutionary models explicitly designed around interacting development functions rather than representative sectors or agents. Politically, it reframes development as a problem not of technical optimization, but of sustaining complex functional complementarities under conditions of conflict and uncertainty.

In this sense, the ultimate implication of the paper is not that societies lack knowledge of individual policy instruments. Rather, sustained development appears to be rare because the construction and maintenance of an integrated functional architecture linking Collective Action, Production, Stabilization and Redefinition of Goals is itself one of the most demanding collective achievements in modern history.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author(s) used ChatGPT in order to support language editing, structural revision, and clarification of formal and conceptual exposition. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

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Appendix A

A Minimal Dynamic Representation of the A–P–S–F Architecture

S1. Purpose of the Supplement

This Supplement provides a minimal formal representation of the functional architecture developed in the main text. Its purpose is **not** to offer a calibrated macroeconomic model, nor to generate quantitative predictions. Rather, it serves as a **conceptual consistency device** that makes explicit the core structural claim of the paper:

sustained generative development requires the joint reproduction of four irreducible functions—Collective Action (A), Production (P), Stabilization (S), and Redefinition of Goals (F)—linked through a configuration of full functional causal closure.

The Supplement therefore plays a strictly logical and structural role. All substantive theoretical, historical, and policy claims are derived exclusively from the main text.

S2. Functional State Variables

Let the development system at time t be represented by the four-dimensional state vector:

$$\mathbf{x}_t = (A_t, P_t, S_t, F_t)$$

where:

- A_t denotes the stock of effective collective coordination and enforcement capacity (Collective Action);
- P_t denotes the stock of productive and technological capabilities (Production);
- S_t denotes the stock of stabilized institutional and macroeconomic expectations (Stabilization);

- F_t denotes the capacity for strategic redefinition of goals and long-run directionality (Redefinition of Goals).

All variables are conceived as **slow-moving structural states**, not short-run adjustment variables. Time is assumed to be discrete ($t = 0,1,2, \dots$) without loss of generality.

S3. A Minimal Dynamic Representation of Full Functional Closure

To formalize the logic of full functional causal closure, consider the following **minimal multiplicative dynamic system**:

$$\begin{aligned} A_{t+1} &= A_t + \alpha_A A_t P_t S_t F_t - \delta_A A_t \\ P_{t+1} &= P_t + \alpha_P A_t P_t S_t F_t - \delta_P P_t \\ S_{t+1} &= S_t + \alpha_S A_t P_t S_t F_t - \delta_S S_t \\ F_{t+1} &= F_t + \alpha_F A_t P_t S_t F_t - \delta_F F_t \end{aligned}$$

with parameters $\alpha_i > 0$ and $\delta_i > 0$ for all $i \in \{A, P, S, F\}$.

In this representation:

- The **common multiplicative term** $A_t P_t S_t F_t$ captures **functional causal closure**: the endogenous expansion of each function requires the simultaneous presence of all the others.
- The linear depreciation terms $\delta_i X_t$ represent structural erosion in the absence of sufficient mutual reinforcement.

This specification is deliberately minimal. It is not intended to be empirically estimated, but to provide a transparent formal anchor for the qualitative claims developed in Sections 3 and 4 of the main text.

Proposition 1 (Necessary condition for endogenous expansion)

If at any time t , at least one of the four variables satisfies $X_t = 0$ for some $X \in \{A, P, S, F\}$, then the common growth term $A_t P_t S_t F_t = 0$ for all equations. The system therefore reduces to:

$$X_{t+1} = (1 - \delta_X) X_t$$

for each $X \in \{A, P, S, F\}$. Hence, in the absence of any one function, **no endogenous expansion of any function is possible**, and all variables weakly decay.

This result formalizes the core conceptual claim of the paper: **no proper subset of functions is sufficient to sustain generative development endogenously**. Only under full functional closure—when all four functions are simultaneously active—can positive feedback operate.

S4. Interpretation of the Dynamic Representation

Under full functional closure and for suitable parameter values such that net growth is positive, the system described in S3 can generate a **self-reinforcing development trajectory** characterized by:

- endogenous reproduction of coordination capacity (A),
- cumulative expansion of productive capabilities (P),
- progressive embedding of outcomes in durable institutional and macroeconomic forms (S),
- continuous strategic redirection of long-run priorities (F).

These four dimensions correspond exactly to the four defining properties of generative development identified in Section 2 of the main text: **endogeneity, cumulativity, irreversibility, and adaptability**.

The representation does **not** imply determinism. It merely shows that a structural configuration exists in which the joint reproduction of these four properties is possible in principle.

S5. Dynamic Failure under Partial Configurations

To illustrate the structural logic of the full-closure argument, consider constrained versions of the system in which one function is permanently absent.

(i) Absence of Stabilization: $S_t \equiv 0$

If stabilization is structurally absent, the common growth term vanishes identically. The system reduces to pure depreciation dynamics. Productive expansion may still occur temporarily through external impulses, but **irreversibility cannot be generated endogenously**. Development remains structurally reversible and exposed to financial, political, and credibility shocks.

(ii) Absence of Redefinition of Goals: $F_t \equiv 0$

If the capacity for strategic redirection is absent, cumulative capability accumulation may occur and may even become institutionally durable. However, **adaptability is structurally excluded**. The system becomes rigid, increasingly vulnerable to technological paradigm shifts, social contestation, and environmental constraints. This configuration corresponds to structural lock-in.

(iii) Absence of Collective Action: $A_t \equiv 0$

If collective coordination and enforcement capacity are absent, innovation, stabilization, and strategic direction may coexist in fragmented form. However, **endogeneity is structurally excluded**. Distributive conflict escalates, enforcement collapses, and political legitimacy erodes. Direction exists without enforceability.

In all cases, the absence of a single function removes one constitutive property of generative development by construction.

S6. Why Dyadic and Triadic Subsystems Are Structurally Insufficient

By definition, generative development requires the joint reproduction of **four logically independent properties**: endogeneity, cumulativeness, structural irreversibility, and transformative adaptability (Section 2 of the main text). Each property, in turn, requires a distinct causal function (Section 3).

A **dyadic or triadic subsystem** is any reduced configuration in which one or more of the four functions is permanently absent. Such a subsystem

necessarily omits at least one constitutive property of generative development. As a result, it may display **internally sustained dynamics**—such as growth, learning, institutional consolidation, or strategic orientation—but it **cannot, by construction, reproduce all four constitutive properties simultaneously**.

In the minimal dynamic representation of S3, this result follows directly: setting any variable permanently equal to zero eliminates the common multiplicative growth term and precludes the joint endogenous expansion of all four functions.

Dyadic and triadic systems may therefore be dynamically viable in a narrow sense, but they are **structurally incapable of generating a fully generative development process** in the strict sense defined in the paper.

S7. Scope, Nature, and Limits of the Representation

This minimal dynamic representation is:

- **non-parametric,**
- **non-calibrated,**
- **non-predictive.**

It does **not** seek to:

- explain growth rates,
- estimate elasticities,
- identify temporal transition paths,
- or generate quantitative policy simulations.

Its sole purpose is **structural**: to demonstrate that the qualitative claims regarding functional causal closure advanced in the main text are logically consistent within a minimal formal framework.

S8. Relation to the Main Text

This Supplement supports:

- the definition of generative development (Section 2),
- the derivation of the four irreducible functions (Section 3),
- and the closure argument (Section 4).

It introduces **no additional substantive assumptions** and does not modify any theoretical, historical, or policy implications derived in the main paper.

All substantive interpretations remain grounded exclusively in the main text.