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Decentralized extractiveness and the Limits of Growth

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Decentralized extractiveness and the Limits of Growth

When Inequality and Merit-Based Remuneration Become Growth-Blocking

Abstract

Traditional growth models explain long-run development through capital accumulation, human capital, technological change, and institutional quality. This paper argues that these drivers are not sufficient for growth when agents in decentralized exchanges are extractive: growth requires a relational feasibility condition that constrains how value is appropriated in decentralized interactions. We define this condition as pre-growth constraint: before standard growth drivers can operate, appropriation must lie within compatible bounds.

To formalize this argument, we develop a relational model with two heterogeneous agents who repeatedly produce and exchange. Each agent is characterized by productivity and appropriation, the latter capturing the degree to which value is captured through pricing and remuneration behavior. From production and budget constraints alone, the model derives a set of necessary conditions for growth.

The model yields three results. First, productivity improvements -including those due to capital accumulation and innovation- are not sufficient for growth when appropriation is extractive; their effect depends on the relational structure of exchange. Second, the range of appropriation compatible with growth expands with aggregate productivity, so more developed economies can sustain a larger appropriation. As a consequence, growth-compatible remuneration is bounded: remuneration that rises too strongly with productivity can become over-merit and block growth by undermining the counterpart's purchasing capacity. Consequently, unequal income distribution limits growth independently of the underlying productivity differential. Therefore, the model suggests that extractive appropriation — even when justified by prevailing notions of merit — can prevent growth.

Authors: -

Keywords: Pre-growth constraint, Growth, Productivity, Appropriation, Inequality, Extractiveness, Merit.

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1 INTRODUCTION

Standard growth theory explains long-run economic expansion through capital accumulation, human capital formation, and technological progress. Institutional economics has extended this framework by showing that inclusive institutions are a precondition for investment and innovation to translate into sustained growth (Solow 1956; Mankiw et al. 1992; Acemoglu and Robinson 2013; Aghion et al. 2021). Yet both traditions largely abstract from the micro-level interactions through which value is actually created and appropriated in decentralized markets. Existing growth models explain how productivity increases, but they say less about whether decentralized exchange relations allow such productivity increase to be exploited and turn into growth This paper takes a first step in that direction.

We argue that before capital accumulation, innovation, and institutional inclusiveness can foster growth, the structure of exchange among agents in decentralized markets must satisfy specific feasibility constraints governing how output is produced and how its value is distributed. In particular, growth requires that productivity systematically dominates appropriation — which relates to the degree to which agents appropriate output through their pricing behavior. When appropriation becomes excessive, i.e., extractive, it prevents growth even when capital, technology, and institutions would otherwise support it.

To investigate this mechanism, we develop a pre-growth model in which two heterogeneous agents repeatedly engage in production and exchange. Each agent is characterized by two parameters: productivity and appropriation. The model derives from production and budget constraints alone, a system of joint inequalities that

constitute necessary conditions for growth. Because these conditions follow from accounting relationships, the only free parameters are productivity and appropriation — the result is not an equilibrium outcome but a feasibility boundary. The model does not describe a full growth process; it identifies the minimal relational conditions under which productivity improvements can propagate into sustained output expansion.

The central implication is that increases in productivity — whether from capital accumulation, human capital formation, or technological innovation — are not sufficient to guarantee growth when appropriation in decentralized interactions is extractive. For any level of productivity, there exist levels of appropriation that violate the growth conditions. Innovation and accumulation are therefore conditionally effective: their growth impact depends on the relational structure within which productivity gains are appropriated.

In brief, even when productivity is potentially sufficient to sustain higher aggregate output, if one agent appropriates too much of the value generated in exchange, the counterpart's purchasing capacity declines and realized production falls below its potential; symmetrically, appropriation that is too low constrains the agent's own revenue and limits its capacity to acquire inputs in the next cycle.

We formalize this argument through two hypotheses.

- H1 states that for any level of aggregate productivity, there exists a level of appropriation sufficiently extractive to prevent growth.
- H2 states that the higher the aggregate productivity, the wider the range of appropriation compatible with growth — that is, more developed economies tolerate higher extractiveness before growth is compromised.

The model yields two implications beyond the two hypotheses. First, remuneration that rises too strongly or too poorly with productivity limits growth because appropriation exceeds the bounds compatible with growth. In that case, over rewarding merit, intended as productivity based remuneration, reduces growth because excessive compensation erodes the counterpart's purchasing capacity and disrupts the exchange process. Symmetrically, a weak link between remuneration and productivity may also constrain growth by limiting agents' capacity to acquire others production. Second and consequently, when inequality increases excessively the resulting income differential is not merely a distributional concern: the higher-income agent produces more than the lower-income agent can afford to absorb, the exchange cycle contracts, and realized output falls below its potential.

The remainder of the paper proceeds as follows. Section 2 situates the argument within the literature. Section 3 presents the relational pre-growth model. Section 4 derives the growth conditions and their structural implications. Section 5 discusses the theoretical and empirical implications of the framework. Section 6 concludes.

2 LITERATURE REVIEW

The most widely known growth model is the Solow growth model (1956) which explains how an economy's output evolves over time through capital accumulation and savings, accounting for diminishing returns to capital per worker and an exogenous level of technology. This framework was later extended to incorporate human capital and technological progress (Mankiw et al. 1992) and to recognize ecological limits as a fundamental boundary to long-term growth (Dasgupta and Heal 1974; Stiglitz 1974; Brock and Taylor 2010). More recently, innovation and creative destruction have been shown to be fundamental drivers of sustained growth (Aghion et al. 2021).

Production and accumulation occur in an institutional and social environment, yet standard growth frameworks do not explicitly model how agents' behavior and their patterns of interaction affect the translation of productivity gains into sustained economic growth. Institutional economics has emphasized that capital accumulation alone is not sufficient for growth when institutions are extractive. Acemoglu and Robinson (2013) show that political and economic systems allowing elites to appropriate disproportionate shares of economic surplus can prevent societies from fully benefiting from investment and technological progress. In such contexts, productivity improvements may coexist with stagnation because the generated surplus is captured rather than reinvested in expanding economic activity.

Related literature highlights the role of social capital and cooperative behavior in sustaining economic development. Trust, reciprocity, and civic cooperation facilitate productive exchange and lower transaction costs,

thereby fostering long-run growth (Putnam et al. 1993; Fukuyama 1996; Pilatin 2022). These contributions suggest that decentralized interactions — with or without formal institutional mediation — independently affect prosperity. If institutional extractiveness can prevent growth despite capital accumulation and technological progress (Acemoglu and Robinson, 2013), a natural question is whether an analogous mechanism may arise endogenously within decentralized market economies, through the way surplus is appropriated in everyday economic interactions.

The concept of extractiveness is related to the institutional distinction between inclusive and extractive systems (Acemoglu and Robinson 2013). We shift the focus from extractive institutions to extractive agents operating in decentralized markets without institutional interference. Extractive agents are those who appropriate an excessive share of resources from others — beyond what is sustainable for the system and justified by their productive contribution — through their pricing behavior. In contrast, the concept of generativity captures the opposite disposition: a person is generative if her work and activities positively contribute to the life of her inner and outer circles (Erikson 1993, 1998), encompassing both attitudes (e.g., willingness to work) and capacities (e.g., human capital) that generate resources for others and for the common good (Bruni and Smerilli 2010; Bruni and Sugden 2013; Becchetti and Bellucci 2021).

Extractiveness need not be confined to institutions. It can also emerge in decentralized exchange when remuneration deviates too strongly from productivity, either upward or downward. In that case, compensation ceases to be a neutral allocation of returns and becomes a feasibility constraint on growth. Over-merit remuneration, by granting compensation in excess of what is compatible with productive contribution, can erode the counterpart's purchasing capacity and thereby disrupt the exchange process. Symmetrically, remuneration that is too low can leave producers unable to purchase the inputs required for the next production round, thereby constraining reproduction of the production–exchange cycle. Merit and its connection to remuneration and productivity may be not neutral with respect to growth.

The civil economy tradition has argued that economic performance depends not only on institutions and incentives but on the relational dispositions of agents — their willingness to generate value for others rather than merely extract it (Sandel 2005; Bruni and Sugden 2013; Bowles 2016). This tradition has produced rich conceptual and normative frameworks but, to our knowledge, no formal model that derives structural growth conditions from individual appropriation behavior. Becchetti and Bellucci (2021) provide empirical evidence on the economic effects of generativity at the individual level, and Bruni and Smerilli (2010) explore the evolutionary dynamics of cooperative and non-cooperative dispositions, but neither connects these behavioral parameters to aggregate growth feasibility through a formal relational model. The present paper attempts to fill this gap: it provides a first formal representation of the civil economy intuition that the balance between generativity and extractiveness at the micro level determines whether productivity improvements can propagate into sustained growth at the aggregate level.

A further relevant strand concerns the relationship between income distribution and aggregate demand. Post-Keynesian economics has long argued that the functional distribution of income between wages and profits is not neutral for growth: when the profit share rises at the expense of the wage share, domestic demand may be insufficient to sustain the expansion of output, generating what Bhaduri and Marglin (1990) formalize as a distinction between wage-led and profit-led growth regimes. Stockhammer and Onaran (2013) provide empirical support for the wage-led characterization of most advanced economies, while Storm and Naastepad (2012) show that wage and price dynamics — rather than supply-side constraints alone — govern the feasibility of sustained expansion. This literature establishes that distributional outcomes in decentralized interactions have macroeconomic consequences for growth feasibility, but it operates at the aggregate level and does not model the micro-relational mechanism through which individual pricing behavior generates these outcomes. The present paper operates at this more fundamental level, deriving the distributional constraints on growth directly from bilateral production and exchange.

The question whether extractive decentralized interactions prevent growth is consistent with recent evidence that advanced economies have experienced a substantial rise in market power and markups, with macroeconomic implications including higher profit rates and weakening transmission of productivity gains into broad-based income growth (De Loecker et al. 2020; Boselgia and Foellmi 2022). In such environments, innovation may coexist with stagnation in real outcomes for large parts of the population because a larger share of the surplus is appropriated rather than translated into expanding economic activity (Piketty and Goldhammer 2014; Boselgia and Foellmi 2022; Lucas et al. 2022). The rise in market power documented by De Loecker et al. (2020) has

prompted a theoretical literature on how firm-level pricing behavior aggregates into macroeconomic outcomes. Blanchard and Giavazzi (2003) show that product market competition affects the wage share and long-run unemployment through markup dynamics, while Philippon (2021) argues that the decline of competition in the United States has generated persistent rents that reduce investment and productivity growth. These contributions establish that pricing behavior at the firm level has structural macroeconomic implications, but they model this relationship through market structure and strategic interaction among firms. The present framework abstracts from market structure entirely and asks a more primitive question: what constraints do bilateral pricing behavior impose on the feasibility of growth, prior to any equilibrium or strategic consideration? In this sense, the present model is not an alternative to the IO literature on markups but operates at a different, more foundational level of analysis.

These considerations motivate the model developed in this paper: a relational pre-growth framework that identifies the behavioral and relational conditions under which productivity gains translate into cumulative growth, rather than being offset by extractive appropriation. The empirical relationships implied by the model are discussed in Section 5, where they are assessed against existing evidence.

3 MODEL

3.1 SCOPE AND INTERPRETATION OF THE MODEL

The model features two heterogeneous agents who interact repeatedly through bilateral cycles of production and exchange. Each agent is characterized by two parameters: productivity (m), which governs the rate at which inputs are transformed into outputs, and appropriation (r), which governs the pricing stance adopted in exchange. The model derives, from production and budget constraints alone, the conditions under which this interaction generates growth. Because these conditions follow from accounting relationships, the only free parameters are m and r: the results hold prior to, and independently of, any assumption about agents' objectives, expectations, or strategic behavior.

Two modeling choices require upfront clarification. First, the model does not explain why agents choose a particular level of production or appropriation. Its contribution is prior to any behavioral theory: it identifies the set of productivity and appropriation values structurally compatible with growth — analogous to a budget constraint in consumer theory, which delimits what is feasible without explaining what is desired. Whether agents reach growth-compatible appropriation through market competition, regulation, cultural norms, or intrinsic motivation is a separate question the model deliberately leaves open. Second, r is not equivalent to the markup as defined in the industrial organization literature (P/MC): it is the ratio of output price to input price, whose economic significance depends entirely on whether it is compatible with the budget constraints governing reciprocal exchange. The precise relationship between r and the feasibility of exchange is derived in the next sections.

3.2 PRODUCTION

Each agent at time t transforms its input $Q_{i,t}$ into output $Q_{o,t}$ according to a linear function:

$$Q_{o,t} = mQ_{i,t}. \qquad (1)$$

where m is the agent's productivity coefficient. For convenience, we will label an agent whose productivity is higher than one (m>1) as productive, vice versa not productive.

3.3 PRICE AND APPROPRIATION

Each agent sets its output price $P_{o,t}$ as a proportion of the input price $P_{i,t}$ it faced:

$$P_{o,t} = rP_{i,t} \qquad (2)$$

The parameter r — appropriation — is the ratio of output price to input price. Taken in isolation, r is a purely nominal pricing coefficient. Its economic significance emerges only within the production–exchange structure: because the price one agent charges determines the other agent's real purchasing capacity, r governs whether the

budget constraints required to sustain reciprocal exchange are satisfied. When r is incompatible with those constraints, the volume of exchange contracts, limiting input acquisition and weakening production. The conditions under which r is compatible with sustained exchange are derived in Section 3.5–3.6.

3.4 AGENT CONVENTION, SEQUENCE, AND INTERTEMPORAL TRANSFORMATION

We adopt an agent-perspective convention: variables belonging to the other agent are denoted with a superscript minus sign. From the perspective of one agent, the other agent's input quantity, productivity, and output quantity are respectively $Q^{-}_{i,t}, m^{-}$ and $Q^{-}_{o,t}$.

The interaction is sequential: at each step t, this agent's output $Q_{o,t}$ is produced by transforming input $Q_{i,t}$, which in turn was received as the other agent's output $Q^{-}_{o,t-1}$ in the previous step. Each agent's output thus becomes the other agent's input — the chain of production and exchange is bilateral and recursive.

Between successive steps the following identities hold:

$$mQ_{i,t} = Q_{o,t}, \qquad P_i r = P^{-}_{o,t} = P^{-}_{i,t+1} = \frac{P^{-}_{i,t+1}}{r^{-}}$$

The identity $Q_{o,t+1} = Q^{-}_{i,t+1}$— *that the agent's output is fully absorbed as the other agent's input — does not hold in general. When the constraints derived in Section 3.5 are binding, employed/consumed input is strictly less than available output:* $Q^{-}_{i,t+1} < Q_{o,t+1}$. The identity holds only when no constraint is binding, i.e., when maximum potential exchange is achieved.

All variables $Q_o, Q_i, m, r, P_o, P_i \epsilon\ \mathbb{R}^{+}$; and m and r are treated as constants.

3.5 INCOME AND CONSUMPTION-PRODUCTION CONSTRAINTS

Three constraints limit the quantity of input an agent can acquire and therefore the output it can produce: its own real income, the other agent's productive capacity, and the other agent's real income and purchasing power.

Real Income Constraint (RIC). The agent cannot buy more input than what its income allows her. The agent uses its entire income (I) given by its previous cycle revenues ($I_t = Q_{o,t-2}P_{o,t-2}$) to buy the input at the input price ($P_{i,t-1}$). From this equation we obtain the real income $Q_{i,t} = \frac{I_{t-2}}{P_{i,t-1}}$ which, in turn, can be rearranged as[1]

$$Q_{i,t} \leq Q_{o,t-1}\frac{m}{r^{-}}$$

Production Constraint (PC). The agent cannot acquire more input than the other agent has produced ($Q^{-}_{o,t-1}$):

$$Q^{-}_{o,t-1} \leq m^{-}Q^{-}_{i,t-1}$$

Other Income Constraint (OIC). The quantity sold ($Q_{o,t}P_{o,t}$) must be lower or equal than the other income ($Q^{-}_{o,t-1}P^{-}_{o,t-1}$) such that $Q_{o,t}P_{o,t} \leq Q^{-}_{o,t-1}P^{-}_{o,t-1}$. Rearranging this formula[2] we obtain the third and last constraint:

$$Q_{i,t} \leq \frac{m^{-}}{m}\frac{r^{-}}{r}Q^{-}_{i,t-1}$$

Consumption constraint. The individual consumption constraint at time t is therefore:

$$Q_{i,t} = \min\left(Q_{i,t-2}\frac{m}{r^{-}},\ m^{-}Q^{-}_{i,t-1},\ \frac{m^{-}}{m}\frac{r^{-}}{r}Q^{-}_{i,t-1}\right) \tag{3}$$

---

[1] $Q_{i,t} = \frac{I_{t-2}}{P_{i,t-1}} = \frac{Q_{o,t-2}P_{o,t-2}}{P^{-}_{o,t-1}} = Q_{o,t-2}\frac{P^{-}_{i,t-1}}{P^{-}_{o,t-1}} = Q_{o,t-2}\frac{P^{-}_{o,t-1}/r^{-}}{P^{-}_{o,t-1}} = \frac{Q_{o,t-2}}{r^{-}} = m\frac{Q_{i,t-2}}{r^{-}}$

[2] $mQ_{i,t}P_{o,t} \leq Q^{-}_{o,t-1}P^{-}_{o,t-1}$, $Q_{i,t} \leq \frac{Q^{-}_{o,t-1}P^{-}_{o,t-1}}{mP_{o,t}}$, $Q_{i,t} \leq \frac{m^{-}Q^{-}_{i,t-1}P_{i,t}}{mrP_{i,t}} = \frac{m^{-}r^{-}}{mr}Q^{-}_{i,t-1}$

3.6 POTENTIAL REAL OUTPUT

When no constraint is binding — that is, when each agent can acquire the full output of the other — the realized input of this agent equals the other agent's output: $Q_{i,t} = Q^{-}_{o,t-1} = m^{-} \cdot Q^{-}_{i,t-1}$. That input is then transformed into output $Q_{o,t} = m \cdot Q_{i,t} = m \cdot m^{-} \cdot Q^{-}_{i,t-1}$. *Since* $Q^{-}_{i,t-1}$ was itself the output of the previous cycle scaled by m, the same multiplicative factor applies at each step. Potential (unconstrained) real output growth factor (g) therefore is given by a factor of m · m⁻ per cycle.

$$g = m \cdot m^{-}$$

When no constraint is binding, the potential real output generated over a full bilateral cycle is:

$$G_t = Q_{i,t}\, m\, m^{-}.$$

If the initial input is normalized to $Q_{i,t} = 1$, potential output equals:

$$G = mm^{-}.$$

Thus, mm^{-}represents the potential (unconstrained) real growth factor of the bilateral production–exchange cycle.

Table 1: Nomenclature

Symbol	Meaning	Symbol	Meaning
m	Productivity	r	Appropriation
RIC	Real income constraint	OIC	Other income constraint
PC	Production constraint	x^{-}	Minus indicates the other agent variable x
$Q_{i,t}$	Input quantity at time t	$P_{i,t}$	Input price at time t
$Q_{o,t}$	Output quantity at time t	$P_{o,t}$	Output price at time t
G	Potential real output		

4 RESULTS: GROWTH PRE-CONDITIONS

This section derives the conditions under which the production–exchange system generates growth by identifying the constraints that must be satisfied for the reproduction of the exchange process. We proceed in four steps. Section 4.1 identifies the individual growth constraints facing each agent, derived from the three budget and production conditions established in equation (3). Section 4.2 aggregates these into a joint system that must hold simultaneously for both agents. Section 4.3 highlights the relational structure of these constraints. Section 4.4 characterizes the range of appropriation compatible with growth.

Throughout, we define growth as an increase in consumption over time: $Q_{i,t} > Q_{i,t-2}$. The analysis focuses on the conditions under which *maximum potential* growth is achieved — that is, we assume the constraints in equation (3) are non-binding, meaning each agent can acquire the full output of the other. This assumption is without loss of generality: if maximum growth fails under these conditions, it fails a fortiori when constraints bind. Conversely, if the conditions are satisfied, growth is feasible.

4.1 INDIVIDUAL GROWTH CONDITIONS

Individual growth requires $Q_{i,t} > Q_{i,t-2}$. Applying this condition to each of the three constraints in equation (3) yields three requirements.

From RIC. The condition $Q_{i,t-2}\frac{m}{r^{-}} > Q_{i,t-2}$ simplifies to:

$$m/r^{-} > 1$$

This agent's productivity must exceed the other agent's appropriation. The higher r^-, the higher m must be to satisfy this constraint.

From PC. The condition $m^- Q^-_{i,t-1} > Q_{i,t-2}$ reduces[3] to:

$$m^- \cdot m > 1$$

The joint productivity of the two agents must exceed one, which is the definition of positive growth ($m^- m > 1 \rightarrow G > 1 \rightarrow g > 0$) under non-binding conditions. Neither agent alone determines this: if one agent is non-productive (m < 1), the other must be sufficiently productive to compensate. If both are non-productive, the constraint cannot be satisfied - regardless of appropriation.

From OIC. The condition $\frac{m^-}{m}\frac{r^-}{r} Q^-_{i,t-1} > Q_{i,t-2}$, under the non-binding assumption, reduces to[4]:

$$(r^-/r)\ m^- > 1$$

This says that growth is limited when this agent's appropriation is high relative to the other's, unless the other agent's productivity compensates, since it limits the other income excessively.

Joint condition. Individual growth requires all three constraints to hold simultaneously:

$$m/r^- > 1 \wedge m^- \cdot m > 1 \wedge (r^-/r) \cdot m^- > 1 \quad (4)$$

These three conditions are not independent: the first governs how this agent's productivity relates to the other's pricing stance; the second governs aggregate productive capacity; the third governs the relative appropriation balance. All three must hold jointly — satisfying two while violating the third is not sufficient for growth.

For the PC and OIC conditions, the derivation requires substituting $Q^-_{i,t-1} = Q^-_{o,t-2}$ that is, assuming the other agent was itself unconstrained in the previous step and acquired its full potential input. This to be true, we must extend growth conditions to the aggregate case, that is, when both agents individual growth conditions are satisfied.

4.2 AGGREGATE

We define aggregate growth as the condition satisfied when both agents satisfy their individual economic growth constraints (equation 4).

$$\left(\frac{m}{r^-} > 1 \wedge m^- m > 1 \wedge \frac{r^-}{r} m^- > 1\right) \wedge \left(\frac{m^-}{r} > 1 \wedge m m^- > 1 \wedge \frac{r}{r^-} m > 1\right)$$

Some simplifications reduce this system.

First, $m^- \cdot m > 1$ and $m \cdot m^- > 1$ are identical and correspond to a positive potential growth rate or g>0: the aggregate productivity condition appears once.

Second, the condition $(r/r^-) \cdot m > 1$ can be rewritten as $(m/r^-) \cdot r > 1$, which is the RIC condition $m/r^- > 1$ multiplied by r. This means the OIC for the other agent is more restrictive than the RIC, and therefore constraining, for this agent precisely when r > 1. When r ≤ 1, the RIC is the binding constraint. The same logic applies symmetrically to the other agent. We can therefore write each agent's binding income constraint as:

$$m^-/r \cdot min(r^-, 1) > 1 \; and \; m/r^- \cdot min(r, 1) > 1$$

where the min operator selects the tighter constraint depending on whether the agent is extractive.

The aggregate growth condition is therefore:

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[3] $m^- Q^-_{i,t-1} > Q_{i,t-2}, m^- Q_{o,t-2} > Q_{i,t-2},\ m^- m Q_{i,t-2} > Q_{i,t-2}$

[4] $\frac{m^-}{m}\frac{r^-}{r} Q^-_{i,t-1} = \frac{m^-}{m}\frac{r^-}{r} Q_{o,t-2} = \frac{m^-}{m}\frac{r^-}{r} m Q_{i,t-2} > Q_{i,t-2}$

$$\frac{m^-}{r}\min(r^-,1)>1\wedge\frac{m}{r^-}\min(r,1)>1\wedge m^-m>1 \quad (5)$$

The three conditions have distinct economic interpretations. The first and second require each agent to be sufficiently productive relative to the other's appropriation: when an agent appropriation exceeds 1 ($r > 1$ or $r^- > 1$), its counterparty must generate enough output to absorb the pricing pressure; vice versa ($r < 1$ or $r^- < 1$), its own productivity must also compensate for the income it forgoes through low appropriation. The third condition requires a positive potential growth rate ($m^-m > 1 \rightarrow g > 0$).

4.3 RELATIONAL ASPECTS

The aggregate conditions highlight two structural features of the growth problem. First, neither extreme appropriation nor its absence inherently supports growth. An agent that is highly extractive erodes the counterparty's purchasing capacity, requiring compensatory high productivity from the other; an agent with very low appropriation undermines its own revenue sufficiency, requiring compensatory high own productivity. Both extremes shift the burden onto productivity rather than eliminating it. Second, the positive potential growth condition $mm^- > 1$ rewards balanced generativity: since the arithmetic mean of two positive numbers exceeds their geometric mean when they differ, equal productivities $m = m^-$ maximize mm^- for a given sum $m + m^-$. An economy of two agents is therefore synergic ($mm^- > 1$), dysergic ($mm^- < 1$), or neutral ($mm^- = 1$) depending on whether their joint productivity clears the growth threshold — and balanced specialization is more likely to clear it than asymmetric one.

4.4 GENERATIVITY AND EXTRACTIVENESS AS PRE-GROWTH CONDITIONS

This section characterizes the range of appropriation values compatible with aggregate growth, as identified by equation (5).

The positive potential production rate $mm^- > 1$ is a prerequisite: if it fails, no configuration of appropriation can sustain growth. Assuming it holds, the admissible range of appropriation for this agent is determined by the first two conditions of equation (5).

The first and second conditions ($\frac{m^-}{r}min(r^-,1)>1\wedge\frac{m}{r^-}min(r,1)$ are satisfied if it is true simultaneously that $\frac{m^-}{r},\frac{m}{r^-}>1$ and $\frac{m^-}{r}r^->1\wedge\frac{m}{r^-}r>1$ as obtained by breaking down the min into the three possible alternatives.

(1) If agents have $r, r^- < 1$, then the conditions are not binding growth if $\frac{m^-}{r}r^->1\wedge\frac{m}{r^-}r>1$. Let as rearrange the formula as if $m^-r^->r\wedge mr>r^-$. Since $r, r^- < 1$ these are satisfied if $m^-r^->1\wedge mr>1$, which in turn can be arranged as $m^->\frac{1}{r^-}\wedge m>\frac{1}{r}$, then an agent setting its appropriation as the reciprocator of its productivity ($r^-\geq\frac{1}{m^-}\wedge r\geq\frac{1}{m}$) does not constrain growth. Since we were considering the case where $r, r^- < 1$, then the condition can be written as

$$1>r^-\geq\frac{1}{m^-}\wedge 1>r\geq\frac{1}{m}$$

(2) In case agents have $r, r^- > 1$, then the conditions are not binding growth if $\frac{m^-}{r}>1\wedge\frac{m}{r^-}>1$, which in turn means that their appropriation must be $r<m^-\wedge r^-<m$. These equations say that agents can appropriate insofar as their appropriation does not exceed the other productivity. Considering the initial assumption, we obtain

$$1<r<m^-\wedge 1<r^-<m$$

(3) In the mixed case, the conditions are $\frac{m^-}{r}r^->1\wedge\frac{m}{r^-}>1$ (or the symmetric case). For the first agent, following what we already showed, the solution is to have $1>r^-\geq\frac{1}{m^-}$, while for the second is $1<r^-<m$. It is possible to generalize saying that there is growth in case both agent respect:

$$m^->r\geq\frac{1}{m}\wedge mm^->1$$

The result is that this agent appropriation degree allowing for growth must be in between the other productivity and this agent productivity reciprocal, assuming that the overall system is synergic altogether. This conclusion

entails that appropriation must not exceed what the other agents produce, which would erode its contribution, and must not be below the inverse of what this agent produces, which would impede its income constraint satisfaction.

These boundaries to appropriation distinguish which agent is *extractive*, having a r above the growth feasible boundaries, *is extracted*, having r below the growth feasible boundaries, and which are neither.

Hypothesis 1. In each of the three possible alternatives, for any degree of productivity (m^-, m, mm^-), there exists an appropriation degree extractive (i.e., sufficiently high) to violate the growth constraints, this supports H1.

Hypothesis 2. In each of the three possible alternatives, the larger the productivity (m^-, m, mm^-), the larger the range of appropriation compatible with growth (i.e., the higher the appropriation that prevents growth), which supports H2.

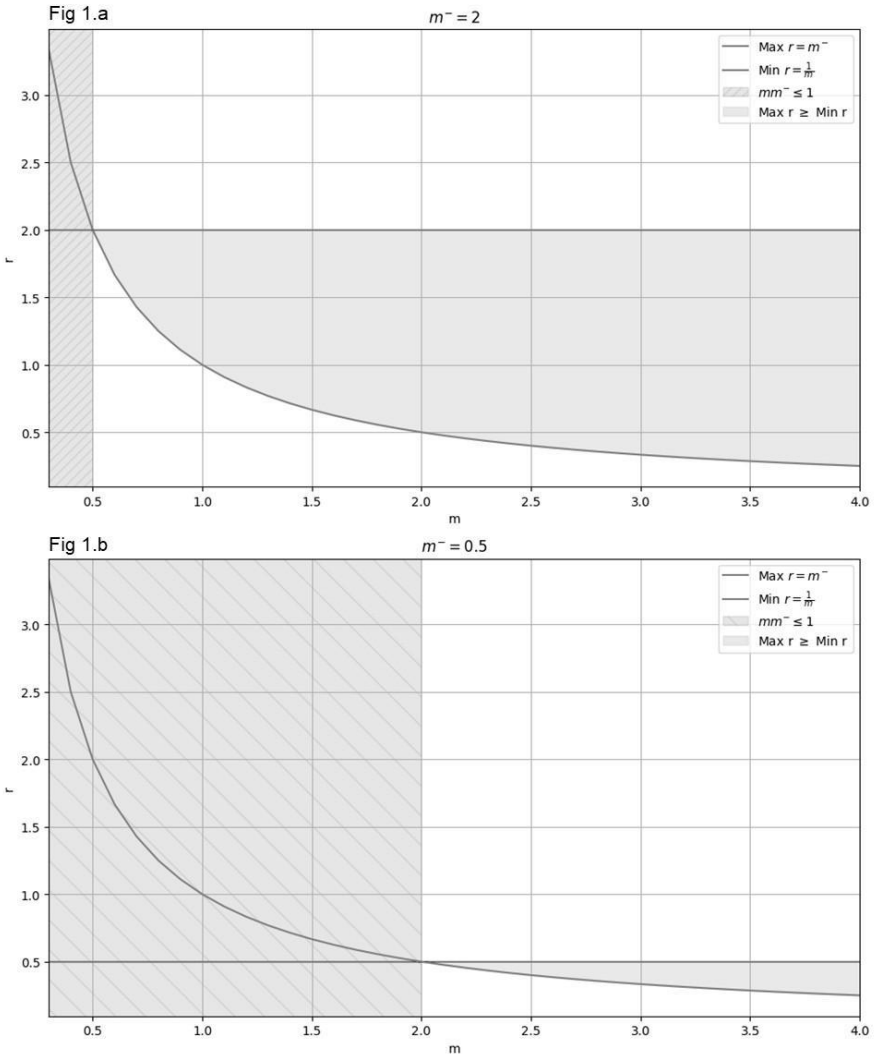


Figure 1 Appropriation compatible with growth (gray area without obliques lines) in case the other agent is productive (m-=2>1, figure.a) and in case is not (m-=0.5<1, figure b) according to this agent productivity (m). The minimum r is given by 1/m, and the maximum r is given by m-. The red zone respects not the aggregate productivity constraint (mm->1)

5 DISCUSSION

This section develops three implications of the pre-growth conditions established in Section 4: the limits that extractive appropriation places on the growth effects of capital accumulation and innovation; the bounds that

growth feasibility imposes on remuneration; and the structural relationship between income inequality and productive capacity.

5.1 EXTRACTIVENESS AND THE LIMITS OF ACCUMULATION AND INNOVATION

This corollary concerns the first hypothesis in dynamic terms. While before we argued that for any level of productivity there exists an appropriation rate that prevents growth, here we extend this limit in case of increasing productivity.

Proposition

An increase in productivity parameters m and m^-, representing capital accumulation or technological progress, is not sufficient to guarantee economic growth when appropriation levels $r, r^- \in \mathbb{R}^+$are unbounded.

Proof

Consider the full system of pre-growth conditions (as in equation (5)):

$$\left(\frac{m}{r^-} > 1 \ \wedge \ m^- m > 1 \ \wedge \ \frac{r^-}{r} m^- > 1\right) \ \wedge \ \left(\frac{m^-}{r} > 1 \ \wedge \ m m^- > 1 \ \wedge \ \frac{r}{r^-} m > 1\right).$$

Suppose that productivity increases due to capital accumulation or technological progress, so that:

$$m' > m, \qquad m^{-'} > m^-.$$

We ask whether such an increase ensures that all growth conditions remain satisfied.

Consider the individual constraints:

$$\frac{m'}{r^-} > 1, \qquad \frac{m^{-'}}{r} > 1.$$

These inequalities fail whenever:

$$r^- > m' \text{ or } r > m^{-'}.$$

Similarly, the relative appropriation conditions:

$$\frac{r^-}{r} m^{-'} > 1, \qquad \frac{r}{r^-} m' > 1$$

can be violated by choosing sufficiently asymmetric values of $r$and r^-.

Since appropriation variables $r$and $r^-$are not upper bounded, it is always possible to select values $(r, r^-) \in \mathbb{R}^+$such that at least one of the required inequalities is violated, even after the increase in productivity.

Therefore, higher productivity alone does not guarantee that the system satisfies all pre-growth conditions. Hence, it is not sufficient to ensure economic growth.

Corollary

For any increase in productivity parameters $m$and m^-, there exist appropriation levels $r, r^- \in \mathbb{R}^+$such that the economy remains in a non-growth regime.

In particular, technological progress or capital accumulation may fail to generate economic expansion if accompanied by sufficiently high (or asymmetric) levels of appropriation. Economic growth requires not only higher productivity, but also that appropriation remains within bounds compatible with the full system of relational constraints.

Discussion

The model highlights that productivity improvements—whether driven by education, technological change, or capital accumulation—do not automatically translate into growth. Growth occurs only when the constraints identified in equation (5) are satisfied. When appropriation exceeds the level compatible with these constraints, i.e., in case of extractiveness, productivity gains do not generate output expansion.

This conclusion holds particular significance for contemporary developed economies. Profit-oriented investment, the financing of highly extractive activities, and the relentless pursuit of competitive advantage—primarily aimed at increasing mark-ups and appropriation—have become structural features of these economies. Indeed, mark-ups in the United States, the world's largest competitive market, rose from 21% to 61%, while corporate profits increased from 1% to 8% over recent decades (De Loecker et al. 2020); free market competition failed to contain profits. Despite substantial technological advancements, the real income of the working class has remained largely stagnant, while economic inequality has surged (Piketty and Goldhammer 2014; Lucas et al. 2022).

Within the framework developed here, these patterns are consistent with an interpretation in which excessive appropriation (extractiveness) weakens the transmission of productivity gains into broad-based growth. When a growing share of the output generated by productivity improvements is appropriated through mark-ups or rents, the customers reduced purchasing power limit the capacity of the economy to absorb such a higher potential output. Innovation and education may therefore be insufficient to generate growth unless the relational structure of economic exchange limits extractive behavior. Nevertheless, the same model predicts that the larger the development of society in terms of productivity, the lower the impact of extractiveness. Hence, more developed societies can develop despite lower equality.

5.2 Remuneration of Productivity and Growth

If for each degree of productivity there exists an appropriation rate so extractive to prevent growth, then it is reasonable to expect that remuneration, linked with appropriation, must also lie in feasible boundaries. The following corollary claims that over remuneration of productivity, which we refer to as over meritocratic remuneration, or under remuneration of productivity, indeed prevents growth.

Proposition: Productivity–Appropriation Compatibility Constraint

Growth requires that appropriation remains within bounds jointly determined by agents' productivity. In particular, for each agent, appropriation must satisfy $1/m \leq r \leq m^{-}$ so that it neither undermines the agent's own income feasibility nor the counterparty's purchasing capacity. Increases in productivity expand the admissible range of appropriation but do not justify proportional increases in appropriation. When appropriation rises with productivity beyond this range, the growth conditions are violated.

Implication

Remuneration mechanisms that systematically align appropriation with productivity—such as strictly proportional or merit-based schemes—may generate configurations in which appropriation exceeds growth-compatible levels, thereby hindering growth.

Lemma: Compatibility of proportional appropriation with aggregate growth

Consider the aggregate growth condition derived in equation (5). Suppose that distribution is governed by a rule such that agent i's appropriation is linearly proportional to its productivity, so that:

$$r = a \cdot m, \qquad with\, a > 0.$$

Then proportional appropriation is compatible with growth only if:

$$1/m^2 \leq a \leq m^{-}/m$$

provided the aggregate productivity condition $m \cdot m^{-} > 1$ is also satisfied.

Proof

From the growth-compatible interval for appropriation $1/m \leq r \leq m^{-}$ and substituting r = a·m, we obtain $1/m \leq a \cdot m \leq m^{-}$. Dividing through by m > 0 yields $1/m^2 \leq a \leq m^{-}/m$

Consequence

The lemma clarifies that the compatibility between productivity and appropriation is conditional rather than monotonic. If $a < 1/m^2$ then r < 1/m, implying insufficient appropriation and a violation of the agent's own income constraint. If instead $a > m^{-}/m$ then r > m^{-}, implying excessive appropriation and a reduction in the counterparty's purchasing capacity. In both cases, growth is prevented.

A particularly relevant case arises when this agent is more productive than the other:

$$m > m^{-}$$

In this case, the upper bound becomes more restrictive in relative terms, since $m^{-}/m < 1$, which means that to have growth

$$a \leq \frac{m^{-}}{m} < 1 \qquad (7)$$

This result admits a distributional interpretation under a specific auxiliary assumption. The agent's nominal income from the production–exchange cycle is $I = Q_o P_o = mQ_i \cdot rP_i$, so that $r = I/(mQ_i P_i)$: appropriation is proportional to income per unit of real input value. If one further assumes that all output is produced by labor — so that $Q_i P_i$represents the wage bill and $I$the total revenue — then the proportionality coefficient $a$in $r = a \cdot m$ can be interpreted as the ratio of revenue per unit of productivity to the unit wage cost, which is inversely related to the labor share.

Under this reading, the condition $a \leq m^{-}/m$ implies that revenue appropriation per unit of productivity must not exceed the ratio of the counterparty's productivity to one's own — restraining, rather than rewarding, relative productivity advantages in the distribution of income. This oppose to theories which advocate in favor of a remuneration which is increasing in productivity (Clark 1899), and meritocratic approach where the more an agent is (relative) productive the larger should be its appropriation. In fact, the larger one's relative productivity, the lower should be the appropriation provided it falls not below the capacity to satisfy the agent's need ($1/m^2$).

Discussion

The distributional implications of the model extend beyond the abstract characterization of appropriation bounds. This corollary establishes that growth requires appropriation to satisfy $1/m \leq r \leq m^{-}$, and that proportional remuneration schemes — in which appropriation scales linearly with productivity — are compatible with growth only within a coefficient interval that narrows as the agent's relative productivity advantage increases. This section draws out the implications of that result for how remuneration should be understood in relation to growth feasibility.

The standard theory of distribution, from Clark (1899) to the neoclassical synthesis, prescribes that each factor should be remunerated according to its marginal contribution to output. Under this logic, higher relative productivity justifies higher appropriation, and meritocratic alignment between productivity and compensation is both efficient and growth-promoting. The model qualifies this conclusion structurally. Because appropriation governs not only the agent's own revenue but also the counterparty's real purchasing capacity, an increase in appropriation that tracks productivity improvement may erode the income feasibility of the production–exchange cycle even as it rewards individual performance. The growth constraint does not operate on each agent in isolation but on the relational configuration of the two agents jointly: what one agent captures, the other must be able to absorb.

The implication is not that productivity-based remuneration is always harmful, but that its growth compatibility is conditional on the productivity of the counterparty. When agents are similarly productive, proportional schemes can remain within the feasible band. When productivity is asymmetric — as is typical between sectors, between firms of different size, or between skilled and unskilled labor — the model predicts that the more productive agent must exercise restraint in appropriation precisely because its advantage is large. This is consistent with empirical evidence that rising wage–productivity gaps, concentrated in high-productivity sectors and superstar firms, are associated with demand compression and slower aggregate growth (Storm and Naastepad 2012; Autor et al. 2020), and with the finding that markup growth in advanced economies has outpaced real output growth, eroding household purchasing capacity (De Loecker et al. 2020).

The model therefore suggests that the design of remuneration institutions — wage-setting mechanisms, profit-sharing rules, markup regulation — is not distributively neutral with respect to growth. Reforms that compress the wage–productivity gap, particularly in high-productivity sectors, may constitute a precondition for sustaining the circular flow of income that the production–exchange cycle requires, rather than a mere equity consideration external to the growth process.

5.3 INEQUALITY AND GROWTH

This section derives a further structural implication of the pre-growth conditions: that income equality is the unique configuration compatible with maximum productive capacity, and that any deviation from it places the system below its growth potential.

Proposition: Income Parity at the Balanced-Appropriation Point

There exists a unique level of appropriation r* = 1/m at which the production–exchange cycle operates at maximum capacity. At this point, and only at this point, the nominal incomes of the two agents are equal.

Proof

For the system to sustain itself at maximum output, each agent must generate sufficient nominal income to purchase the other's entire production. Equating the value of the other agent's production, $Q_{i,t}^{-}m^{-}P_t^{-}$, to the income generated by this agent's production, $Q_{i,t}mP_{t+1}$, and iterating via $P_{o,t} = rP_{i,t}$, yields:

$$Q_{i,t}^{-}m^{-}P_t^{-} = Q_{i,t}mP_tr = Q_{i,t}^{-}m^{-}mm^{-}P_t^{-}rr^{-} = \cdots$$

From the equality of the first and second expressions:

$$r^* = 1/m$$

At r=r**, each agent's output price is the reciprocal of its productivity applied to the input price, so the nominal value of what each agent produces exactly equals the nominal income of the other. Income parity follows directly from the balance condition: if each agent can just afford to purchase the other's entire output, and outputs are valued at their full sale price, then nominal revenues are equal by construction. Any deviation from r** — in either direction — breaks this balance: when r > r**, this agent captures more nominal income than the other can absorb; when r < r^**, this agent's revenue is insufficient to sustain full exchange. In both cases the system operates below maximum capacity, and income parity is lost.

Three notes are useful for clarity. First. The chain is valid because each agent has the same income. As a consequence, r* guarantees income equality and income equality guarantees the production-exchange cycle continuation. Second. When r>r* then there is a markup since the price increases more than what sufficient to cover the agent's cost. Consequently, a measure of markup is $\mu = \frac{r}{r^*} - 1 \left(= \frac{r}{m} - 1\right)$. It follows that the larger the markup, the higher the distance from the optimum and the lower the production – as a mere result of budget constraints. Third. Not observing agents with r=r* diminishes production but does not prevent growth; growth can happens provided r lies within the range of equation 5.

Corollary: Inequality as Distance from the Optimum

Since r* *is the unique appropriation level compatible with both maximum productive capacity and income parity, any income inequality between agents is a signal that appropriation has deviated from r** and that the system is operating below its growth potential. The greater the deviation of the income ratio from unity, the further the system is from the configuration that maximizes the reproduction of the production–exchange cycle. This connection between inequality and sub-optimal growth is not a behavioral assumption but a structural consequence of the budget constraints governing bilateral exchange.

Discussion

The result inverts the standard framing of the inequality–growth relationship. The question is not whether inequality incentivizes effort and productivity — it may — but whether the income configuration resulting from appropriation choices remains compatible with the full circulation of purchasing power that sustained growth requires. When incomes diverge, the lower-income agent's capacity to absorb the higher-income agent's output is diminished, the Other Income Constraint becomes binding, and the production chain contracts. Inequality is therefore not merely a distributional outcome of growth but a symptom of the same feasibility failure that blocks it.

The budget constraint in demand terms is related to the structure of Keynes's principle of effective demand (1936), where aggregate output is limited not by productive capacity but by the capacity of agents to absorb available production at prevailing prices. In the present model this mechanism operates at the micro-relational level: it is not aggregate demand in the Keynesian sense, but the bilateral purchasing feasibility between two agents that governs whether output can propagate through the system. The connection is therefore structural rather than

analogical— contraction arises because one agent's nominal pricing outruns the other's real purchasing power, not because productive capacity is absent. This resonates with post-Keynesian traditions emphasizing that wage and price dynamics, rather than supply-side constraints alone, govern the feasibility of sustained expansion (Storm and Naastepad 2012), and with the literature on profit-led versus wage-led growth regimes, in which the distribution of income determines whether demand is sufficient to sustain the production cycle (Bhaduri and Marglin 1990; Stockhammer and Onaran 2013).

5.4 EMPIRICS COMPATIBLE WITH THE THEORY

This section assesses the empirical consistency of the two hypotheses against existing evidence. H1 states that for any level of productivity there exists a degree of appropriation sufficiently extractive to prevent growth; H2 states that the range of appropriation compatible with growth widens with aggregate productivity, so that extractiveness is more severely constraining at low development levels than at high ones. Because appropriation is not directly observable, the assessment proceeds through proxies — income inequality, markups, wages, rent-based incomes, and wage–productivity differentials — each of which captures a dimension of the distance between actual appropriation and the growth-compatible band identified in equation (5).

The clearest proxy for excessive appropriation is income inequality. A lower bottom-50% income share signals that the income ratio between agents has moved away from the parity configuration r* = 1/m, placing the system below its maximum productive capacity. Figure 2 illustrates this pattern cross-sectionally: across countries in 2019, a lower bottom-50% share is consistently associated with lower GDP per capita, with the relationship most pronounced among less developed economies and more dispersed at higher income levels. This is precisely the pattern H2 predicts — at low G, even moderate inequality activates the budget constraints; at high G, the feasible band is wider and diverse distributional configurations can coexist with growth — but the optimum remains income parity, and distance from it always carries a cost in productive capacity.

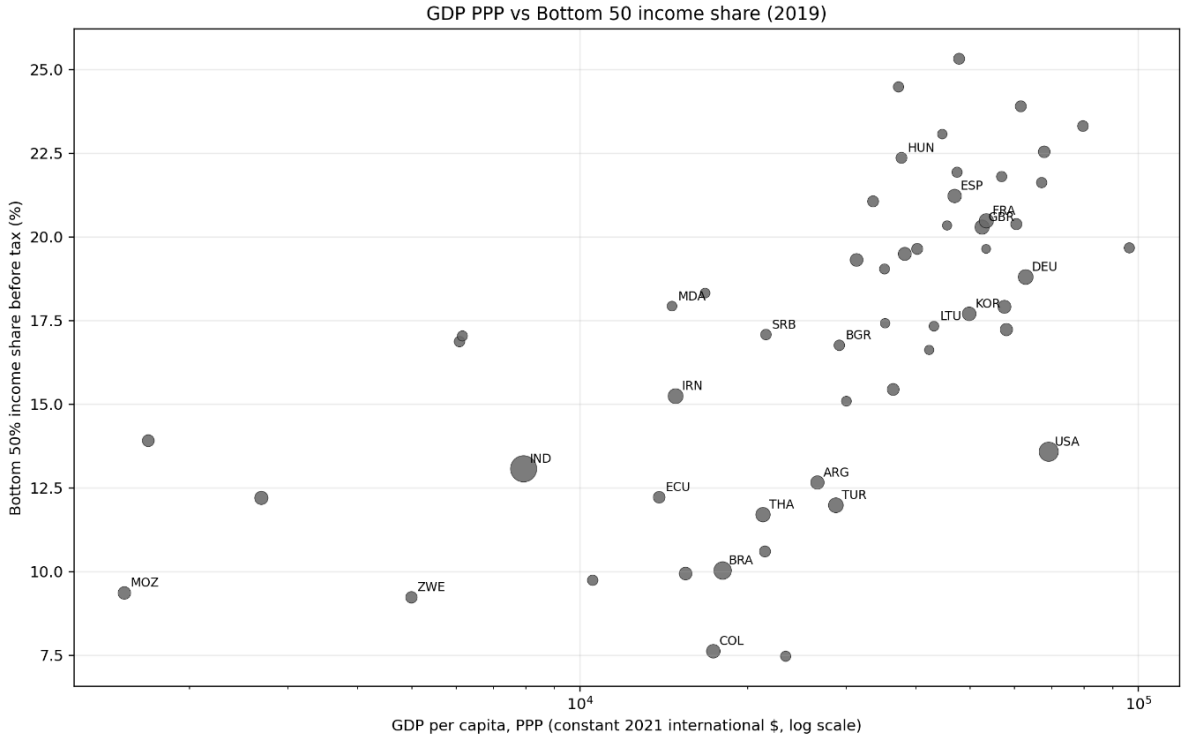


Figure 2 Bottom 50% and GDP PPP. The figures show that the larger the inequality (bottom 50% distance from 0.5), the lower the aggregate production. The GDP per capita (PPP) data is from the World Bank's World Development Indicators (World Bank 2025), and the bottom 50% income share from the World Inequality Database (World Inequality Database 2025).

The bottom 50% income share measures the proportion of total national income accruing to the poorest half of the population, capturing the extent of income concentration and distributional inequality

The theory implication that that high inequality entails the absence of growth can be tested using the sufficient condition framework, based on the joint verification of modus ponens and modus tollens through Bernoulli tests on restricted subsamples (Becchetti and Bova 2025). Using cross-country data for 2019, the latest date allowing a sufficient number of combined observations for GDP per capita PPP from the World Bank (2025) and bottom 50% income share from the World Inequality Database (2025), we define thresholds at USD 30,000 for GDP per capita and 20% for the bottom 50% income share, classifying observations as high GDP and high inequality accordingly. The bottom 50% income share is selected as a measure of inequality in line with the two-agent structure of the model. The empirical results show no violations of the modus ponens and no violations of the contrapositive in the relevant subsample. Given the limited sample size, the Bernoulli test supports the condition at the 10% significance level but not at more stringent levels. These findings are consistent with the theoretical mechanism but remain indicative rather than conclusive. They are presented to illustrate the empirical compatibility of the framework and to motivate further research based on larger samples and more refined identification strategies.

Barro (2000) finds that inequality is negatively associated with growth in poorer countries while the relationship weakens in richer economies, consistent with the widening of the feasible band. Banerjee and Duflo (2003) document a non-linear inequality–growth relationship in which distance from an optimal inequality level reduces growth, a formulation structurally analogous to the model's distance-from-r* interpretation. The attenuation at high income levels is not, however, robust: OECD (2015) and Marrero and Servén (2022) show that inequality remains harmful in advanced economies through human capital and demand channels, and Brueckner and Lederman (2018) find that the negative effect of inequality on growth is decreasing in initial income — consistent with H2 but not implying that the constraint disappears.

A similar development-stage gradient emerges for markups, which proxy for the upper bound of the appropriation band. High markups signal that r is approaching or exceeding m^{-}, eroding the counterparty's purchasing capacity. In less developed economies, high markups predominantly reflect entry barriers and weak competition rather than innovation rents, and their growth-blocking effect is more immediate (Diez et al. 2018). In advanced economies, part of the markup increase reflects Schumpeterian rents accruing to superstar firms, which can coexist with growth precisely because G is large enough to accommodate them — but the negative macroeconomic effects are not eliminated(Autor et al. 2020; De Loecker et al. 2020). The secular rise in markups in the United States from approximately 21% to 61% over recent decades, documented by De Loecker et al. (2020), represents a sustained movement toward the upper boundary of the feasible band, consistent with the stagnation of real wages despite productivity growth.

Low wages operate through the opposite channel, pushing r below 1/m and constraining the agent's own revenue sufficiency. In low-income contexts this manifests as demand compression and reduced capacity to finance the next production cycle; in advanced economies the effect is less immediate but persists through weaker domestic demand and human capital accumulation (Storm and Naastepad 2012; OECD 2015). Rent-based incomes follow the same pattern: consistently growth-blocking in low-development settings due to rent-seeking and institutional capture (Mehlum et al. 2006; van der Ploeg 2011), and associated with lower investment and productivity growth even in advanced financial structures (Piketty and Goldhammer 2014; Philippon 2021).

The wage–productivity differential provides the most direct empirical counterpart to the model's appropriation band. When wages and productivity move together, the system operates near r*, close to the growth-compatible frontier. When wages persistently lag productivity — as documented for most advanced economies since the 1980s (Storm and Naastepad 2012; Autor et al. 2020) — appropriation has risen above the balanced-exchange point, eroding purchasing capacity and compressing demand. The reverse configuration, wages systematically exceeding productivity, pushes r below the lower bound, constraining profitability and investment. Balanced alignment supports sustained growth; large and persistent gaps in either direction is associated with macroeconomic imbalances, consistent with the model's symmetric feasibility constraint.

The literature on meritocratic wage-setting adds a further dimension. Stronger links between individual productivity and compensation can support allocative efficiency and incentives for human capital accumulation (Clark 1899), particularly at early development stages where the feasibility band is narrow and both under- and over-appropriation carry immediate costs. However, as established in Section 5.2, proportional remuneration

schemes are growth-compatible only within a coefficient interval that narrows as relative productivity advantage increases. Empirical evidence that meritocratic wage-setting must be balanced with inclusiveness considerations in advanced economies(OECD 2015; Aghion et al. 2019) is consistent with this structural constraint: the more productive agent's ability to appropriate in proportion to its advantage is precisely what the model limits.

Overall, the evidence is compatible with a conditional interpretation that maps onto H2: distortions associated with excessive or insufficient appropriation — inequality, high markups, rent extraction, wage suppression, and large wage–productivity gaps — are more severely growth-blocking at low levels of development, where the feasible band is narrow, and less immediately so at high levels, where the band widens. This attenuation does not imply that the constraint disappears; it implies that more developed economies can tolerate larger deviations before the budget constraints bind. The optimum — income parity at r* — remains the unique configuration compatible with maximum productive capacity regardless of development level, and distance from it always carries a cost, even when that cost does not manifest as outright contraction.

5.5 VALIDATION AND LIMITATIONS

The model generates a set of empirically testable implications that follow directly from the relational growth constraints. First, when appropriation exceeds the growth-compatible bounds, realized output falls below its potential level even if productivity is sufficient to sustain expansion. This implies that economies with similar levels of technology and human capital may display systematically different growth outcomes depending on the distribution of appropriation. Second, increases in productivity—whether driven by capital accumulation, human capital, or innovation—do not guarantee growth if appropriation adjusts beyond the admissible range. In this sense, the model predicts a conditional relationship between productivity and growth, in which the transmission of productivity gains depends on the relational feasibility of exchange. Third, the model implies an asymmetric relationship between development and inequality. When aggregate productivity is low, the range of appropriation compatible with growth is narrow, so deviations more easily activate the constraints. At higher levels of productivity, the admissible range widens, allowing more heterogeneous distributional configurations to coexist with growth, although deviations from the balanced configuration continue to reduce potential output. Preliminary empirical evidence is consistent with these implications. The sufficient-condition test based on GDP per capita (PPP) and the bottom 50% income share identifies a pattern in which low development is systematically associated with high inequality, in line with the model's prediction that growth constraints bind more tightly at low productivity levels. Given the limited sample size and the threshold-based nature of the test, this evidence remains indicative and is presented as a first validation exercise rather than a definitive result.

It is important to stress that the model is built on a set of simple relational and budget constraints governing production, prices, and income flows between agents. The key results therefore follow from relationships that are close to accounting identities linking production, exchange, and income feasibility. The contribution of the framework is not to introduce additional behavioral assumptions, but to show that the interaction between productivity and appropriation generates structural limits to growth that operate prior to, and independently of, standard growth mechanisms.

Several limitations follow from the deliberately minimal structure of the model. First, the framework considers only two agents interacting in a sequential production–exchange relationship. This dyadic structure is useful because it isolates the basic relational constraint between productivity, appropriation, and purchasing capacity; however, real economies are composed of networks of agents, sectors, and firms. Extending the model to multi-agent and network structures would allow future research to analyse how extractive appropriation propagates through production chains and whether local violations of the growth conditions generate aggregate contraction.

Second, productivity and appropriation are treated as exogenous and constant parameters. This choice is consistent with the purpose of the paper, which is to identify feasibility conditions rather than to explain the behavioural origin of productivity or appropriation choices. Nevertheless, in real economies both variables evolve over time. Productivity may depend on investment, learning, innovation, and distance from the technological frontier, while appropriation may be shaped by market power, institutions, bargaining capacity, norms, and strategic behaviour.

Future work should therefore endogenize these parameters and study how the system behaves when productivity and appropriation adjust dynamically. [5]

Third, the model abstracts from several mechanisms commonly included in growth theory, such as capital accumulation, financial markets, technological diffusion, and policy intervention. This abstraction is intentional, since the paper aims to identify a pre-growth constraint that must hold before standard growth drivers can operate. Integrating these mechanisms would allow future research to examine how relational constraints interact with capital accumulation, innovation, redistribution, and competition policy.

Finally, the empirical evidence presented here remains preliminary. Appropriation is not directly observed and must be proxied through variables such as income inequality, markups, rent extraction, wage suppression, or wage–productivity gaps. The sufficient-condition test based on GDP per capita PPP and the bottom 50% income share provides only indicative evidence, due to the limited sample size and the threshold-dependent nature of the exercise. Future empirical work should therefore develop more direct measures of appropriation and generativity, test alternative thresholds, use larger cross-country and longitudinal datasets, and assess whether the sufficient condition remains robust across development levels and institutional contexts.

Despite these limitations, the model provides a simple theoretical framework highlighting a fundamental insight: productivity improvement alone is not sufficient to guarantee economic growth when appropriation is not in the growth feasible range.

6 CONCLUSION

The model shows that economic growth requires a relational balance between productivity and appropriation. When appropriation exceeds the limits compatible with the production–exchange cycle, productivity gains may fail to translate into growth even when capital accumulation, innovation, and formally inclusive institutions are present — because inclusive institutions govern the rules of the game at the systemic level, but do not determine directly how individual agents appropriate value in decentralized bilateral exchanges. The pre-growth constraint operates at this more primitive level, prior to and independently of institutional design. It is a structural feasibility

[5] Equation (2) links current production to inputs generated in previous production–exchange steps. As a consequence, the system is inherently recursive: output produced in one period becomes the input for subsequent periods. This implies that the growth conditions derived in equation (5) have dynamic implications. When the aggregate growth constraints are satisfied, the system generates a feasible multiplicative expansion of production across successive production–exchange cycles. Conversely, when the constraints are not jointly satisfied, output contracts recursively and the system may enter a cumulative decline. However, in the present framework productivity and appropriation are treated as constant parameters. For this reason the model should be interpreted as identifying the instantaneous feasibility conditions for economic expansion, rather than describing a complete dynamic growth process.

A simple way to connect the present framework to a fully dynamic growth model would be to allow productivity to evolve over time. For instance, productivity at time $t$could be modeled as a function of the distance between maximum feasible production $Q^*$and actual production Q_{t-1}:

$$m_t = m(Q^* - Q_{t-1})$$

where $m_t \geq 0$. Under this formulation productivity declines as production approaches its technological frontier, reflecting decreasing returns to scale. In particular, there may exist a level of production Q_{t-1}such that $m_t < 1$, implying that further expansion becomes infeasible.

Under such dynamics, the interaction between productivity evolution and appropriation would determine the long-run behavior of the system. When appropriation remains within the ranges compatible with the pre-growth constraints derived in equation (5), the system may converge to a steady state or sustain expansion. When appropriation exceeds those thresholds, productivity gains may fail to translate into sustained growth.

constraint, derived from accounting relationships alone, that must be satisfied before standard growth drivers can become effective.

The central implication for remuneration is that growth-compatible compensation is not simply merit-based. When remuneration rises too strongly with productivity — becoming over-merit — appropriation exceeds the relational bounds required for the exchange cycle to reproduce itself. The more productive agent captures a share of surplus that the counterpart cannot absorb, eroding purchasing capacity and blocking the transmission of productivity into growth. The model shows that this is not merely a distributional concern: it is a structural feasibility failure. Growth requires remuneration to remain within bounds jointly determined by the productivity of both agents — for the more productive agent, these bounds may become relatively tighter as its productivity advantage increases.

The broader implication is that reducing extractiveness — through wage-setting mechanisms, profit-sharing rules, markup regulation, or behavioral norms — is not merely an equity consideration but a structural precondition for growth. Especially in low-productivity contexts, where the feasible band is narrow, even moderate misalignments between productivity and appropriation can prevent expansion. Conversely, aligning appropriation with growth-compatible bounds allows productivity gains to translate into growth. The model further implies that, since optimal appropriation is the inverse of productivity, income equality maximizes growth, while any distance activates budget constrains limiting growth.

This result provides a micro-relational complement to institutional theories of growth. Just as extractive institutions can prevent societies from benefiting from investment and innovation, extractive behavior in decentralized market interactions may generate analogous macroeconomic outcomes — without any institutional failure. Growth therefore depends not only on technological progress or capital accumulation, but also on the relational conditions under which agents interact and appropriate surplus. Reductions in extractiveness may constitute a necessary precursor to effective capital accumulation and innovation, particularly where productivity remains low and the feasible band of appropriation is narrow.

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