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Sustainable development in a center-periphery model

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Abstract

Latin American Structuralism is an important strain in development theory, one which focuses on the center-periphery dynamics arising from an international economy ridden by technological, financial and power asymmetries. This paper discusses recent Structuralist contributions around the concept of sustainable development, defined as a growth path that is sustainable in three dimensions: economic, social and environmental. The economic dimension of sustainability means that the effective rate of growth is compatible with the Balance-of-Payments constraint; the social dimension means that growth is inclusive and reduces inequality; and the environmental dimension means that it respects the ecological boundaries of the planet. There are no endogenous market forces that could deliver a sustainable growth path: the role of politics and political negotiations (at the domestic and international levels) is paramount. The effective path that will be observed emerges as political power and structural change co-evolve and create tensions and disequilibria, shaping income distribution and the direction of industrial transformation and technological change.

Keywords: Center-periphery models; Structuralism; sustainable development

JEL codes: O11; O43; 044.

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Introduction

This work discusses recent contributions to the theory of growth and distribution in the tradition of Latin American Structuralism and center-periphery models. It first presents the basic model and then focuses on questions that Structuralists have raised recently, particularly the analysis of the necessary conditions for sustainable development. The Latin American Structuralist School is defined as a collection of theoretical and empirical contributions that have at its core the center-periphery approach set out by Raul Prebisch in his 1948 manifesto (see Prebisch 1949). While most authors in this tradition worked for or interacted closely with the United Nations Economic Commission for Latin American and the Caribbean (ECLAC), Latin American Structuralism should not be seen as confined to Latin America or ECLAC. It is an integral part of heterodox growth theories, one that focuses on the specific problems faced by laggard economies in in an international system ridden by technological, productive and financial asymmetries. In this sense, this working paper addresses more generally center-periphery models, some of which may be relevant not only for Latin America, but also for the global South or even peripheral regions in developed economies.

Recent extensions in the Structuralist tradition discussed the concept of sustainable development, defined as a growth path that is sustainable in three dimensions: the economic dimension, which means that the rate of growth is compatible with the Balance-of-Payments constraint; the social dimension, which means that growth is inclusive and reduces inequality; and the environmental dimensions, which means that it respects the ecological boundaries of the planet. Section 1 discusses the Balance-of-Payments Constraint in the context of a simple center-periphery model and extends it to include the environmental dimension. Section 2 integrates the economic and environmental dimensions with the social one. It also analyzes how power and the interests of different actors in democracy concur to define the parameters and potential outcomes of the model, including a sustainable development path. A final section concludes.

The paper focuses on advances in Structuralism while keeping key features of the "old" tradition, in particular the focus on asymmetries and barriers to structural change emerging from the concentration of power and income. It also aims to open doors for insights from other social sciences and heterodox schools in order to create opportunities for conversation and cross-fertilization among those interested in the problems of economic development[1]. In particular, the concept of social inclusion used in this work goes beyond economic inclusion and takes on board the strong concern shown by the Latin American Structuralists with the preservation of political democracy, which has been a major challenge for the region (Prebisch, 1981; Sunkel, 1992).

1. The center-periphery model and the environmental gap

1.1. The technology gap and international competitiveness

Center-periphery models address the impact on economic development of technological, financial, and productive asymmetries in the international system—which also imply power asymmetries in defining the

[1] To a modest extent, it follows the approach set forth in Dobush and Kapeller (2012, p. 1043) who argue in favor of an "interested pluralism", which is "striving for constructive interaction between different theoretical traditions".

rules of the game in international and domestic politics. The model takes as a point of departure the existence of a technology gap between two regions, the center on the technological frontier and the periphery that lags behind. Those on the technological frontier have the capabilities required to produce a diversified set of goods and services, some of them highly sophisticated from a technological standpoint. Inversely, as a technological laggard, the periphery is specialized in few low-tech sectors and exports mainly commodities (see Felipe et al, 2012; ECLAC, 2020). This production structure makes it very much dependent on imports, notably of capital goods, and vulnerable to fluctuations in commodity prices in the international markets. These supply-side variables have demand-side implications: more technology-intensive economies show a high income elasticity of the demand for exports (ε) vis-à-vis the income elasticity of the demand for imports (m). Such difference in the dynamism of the demand of exports and imports gives rise to differences in the rates of growth consistent with equilibrium in current account, as argued in the Balance-of-Payments-constrained growth models.

Formally, in a two-region system in which P represents the periphery and C the centre, the long-run rate of growth with equilibrium in current account is given by Thirwall's Law[2]:

(1) $y^P = \frac{\varepsilon}{m} y^C$

If y^P is higher than $(\varepsilon/m)y^C$, imports grow at a higher rate than exports and the periphery will need more external finance to pay for its imports. As the debt to GDP ratio increases, the risk of lending to the periphery is on the rise. After some critical debt level, the periphery will be obliged to curb its growth rate to correct the external imbalance and comply with equation (1). Since the center is more technology-intensive than the periphery, the ratio between the income elasticities of the demand for exports and imports tends to be smaller than unity in the latter ($\frac{\varepsilon}{m} < 1$), except in periods of highly favorable terms of trade (i.e. periods in which the periphery benefits from good luck in the commodity lottery). The center can therefore grow at a higher rate than the periphery, which implies divergence in the international economy ($y^C/y^P = \varepsilon/m < 1$).

There is a financial asymmetry that complements asymmetries in international competitiveness. The periphery cannot issue an internationally accepted reserve currency and hence must finance its external deficits by issuing debt in a foreign currency (the "original sin"; see De Paula et al, 2017, and Herr and Nettekoven, 2022, on the "hierarchy of currencies" and its implications for the periphery). If the debt to GDP ratio or the debt to exports ratio increases over time, the international financial markets will eventually stop lending to the periphery, which triggers a recessive or contractionary phase. Thus, structural and financial variables concur to make the external sector the binding constraint on growth in the periphery. Ocampo (2016) has called such dynamics "Balance-of-Payments dominance" in macroeconomic policy. Financial globalization and open capital accounts exacerbate the and give to international financial actors a de facto veto power over economic policy (Kaltenbrunner and Painceira, 2015; Botta et al, 2023; Palma, 2023).

Structural change and growth affect the labor market. In the center, higher, more stable growth allows to bsorb most of the workforce in formal jobs with high productivity. Inversely, slower growth and poor diversification give rise to a fragmented labor market in the periphery, where a substantial share of total employment is underemployed or employed in subsistence sectors —what Pinto (1970) called "structural

[2] For a review and extensions see Thirlwall (2011), Blecker (2022) and Blecker and Setterfield (2019, chapter 9).

heterogeneity", a term that remains a central description of employment problems in the periphery and, increasingly, in developed economies.

In short, the technology gap entails different economic structures with an impact on the growth of exports and imports, and (mediated by the hierarchy of currencies) on the rates of economic growth and the quality of employment. In the next subsection these ideas are presented using a very simple technology-gap model that will be gradually made a bit more complex, by adding the environmental and social dimensions.

1.2. The dynamics of the gap and international specialization in a center-periphery model

The model is very much within the "Schumpeter meeting Keynes" approach suggested by Dosi et al (2010). The discussion starts with the analysis of the determinants of the technology gap drawing from the Schumpeterian (evolutionary) thinking on technological change[3]:

(2) $\dot{G} = g(G, A), G = \log(\frac{T^C}{T^P}), G > 0$

Equation (2) is the motion equation for the technology gap G, which is defined as the log of the ratio between technological capabilities in the center (T^C) and those in the periphery (T^P). The evolutionary literature suggests that the dynamics of the technology gap depends on both the initial level of the gap itself and the "absorptive capabilities" (A) of the laggard economy. The concept of absorptive capabilities was first defined by Cohen and Levinthal (1990) and refers to the ability of firms to recognize the "value of external information, adopt, internalize and use it" to foster productivity growth and innovation. The parameter A can also be seen as a "technological infrastructure", as suggested by Freeman (2004). These absorptive capabilities depend on the set of institutions and investments directed at fostering learning and innovation (the "National System of Innovation") but also on the "social infrastructure" (Onaran et al, 2022) that contributes to the development of human capabilities (see below).

The relationship between changes in the gap and the level of the gap may take different forms, but it is generally accepted to be nonlinear (Verspagen, 1993, chapter 6, is an early formalization of this nonlinearity; see also Fagerberg and Verspagen, 2002; Criscuolo and Narula, 2008; Spinola, 2020; Bianchi et al 2023). The discussion that follows is a simplified version of the models of international trade by Dosi et al (1990, chapters 6 and 7) and Verspagen (1993). In particular, it is assumed a one-sector open economy in which structural change is represented by changes in the income elasticity of exports and imports and by changes in the carbon intensity of GDP growth (see appendix 1 for a presentation of the model in a multigoods setting).

We assume that the periphery is a small country and the rate of growth of technological capabilities in the center is an exogenous constant T^C represented by a straight line in quadrant I in figure 1 (Northwest). For the periphery, the gap represents a stock of technology that it can use to accelerate its own technical change out of international technological spillovers. Given A, for low levels of the gap, $G < G_t$, an increase in the gap accelerates learning in the periphery (increases T^P) as it draws from technological advances in the center ("catching up"). Still, after some critical level $G > G_t$, the technological backwardness of the

[3] See Dosi and Nelson (1994). The evolutionary theory of technical change is the necessary complement, at the firm and sector levels, of the center-periphery model (Porcile, 2021). An early combination of evolutionary and Structuralists insights is Cimoli and Katz (2003).

periphery is so high that it becomes more difficult to learn from the existing technology—and therefore the rate of international technological diffusion falls. When the horizontal line of the growth of innovations in the center meets the quadratic function representing the international diffusion of technology towards the periphery, the gap will be in equilibrium, $\hat{T}^C = \hat{T}^P => \dot{G} = 0$.

There are two equilibrium points in the initial scenario, one of which is stable (G_0^*) and the other unstable (G_0^U). A rise in absorptive capabilities A —which requires investments in R&D, education, health and the caring economy— shifts the $\hat{T}^P$ curve upwards (from the dashed line to the full line) and lowers the gap in equilibrium (from G_0^* to G_1^*). Note that the set of values of the technology gap leading to a stable equilibrium increases from G_0^U to G_1^U after the increase in A. In the extreme case of too low absorptive capabilities (dotted line below the dashed line), international technological spillovers will always be below the rate of innovation in the center ($\hat{T}^C$) and hence divergence prevails, in which case there is no equilibrium gap (the periphery persistently lags behind, since $\hat{T}^P < \hat{T}^C$ and $\dot{G} > 0 \; \forall \; G > 0$).

In sum, per equation (2), the equilibrium value of G and the range of G values compatible with the stability of the system depend on absorptive capabilities A. Equation (3), in turn, maps the equilibrium technology gap into the income-elasticity ratio: a higher technology gap implies a less technology-intensive economy and hence a lower income elasticity of exports compared to that of imports.

(3) $\frac{\varepsilon}{m} = f[G^*(A), \mu, \omega], f'(G^*) < 0, \; G'(A) < 0, f'(\mu) > 0, f'(\omega) < 0$

(4) $y^P = \frac{\varepsilon}{m} y^C = f[G^*(A), \mu, \omega] y^C$

Equation (3) acknowledges two other forces affecting international competitiveness, besides A. The first is the share of green capabilities in total absorptive capabilities, μ. The inclusion of μ in the argument of the competitiveness function reflects the growing international concern with environmental sustainability in international trade negotiations and the possibility that trade barriers would emerge to curb carbon-intensive exports (for instance, a carbon tax on the borders as the one discussed in the European Union). This is related to the "Porter Hypothesis", the idea that pro-environment regulations can become a competitive advantage. To such an outcome contributes the dissemination of pro-environment sentiments across economic actors as the negative consequences of climate change become common knowledge, as argued by Dávila-Fernández and Sordi (2020). The role of μ in competitiveness may also come from technological externalities associated with investments in green technological capabilities. Indeed, using the economic complexity index (ECI) as an indicator of the technological intensity of the production structure, Romero and Gramkow (2021) shows that lower emissions per unit of GDP tend to go hand in hand with a higher ECI.

Finally, the argument of the competitiveness function includes the wage share ω in GDP as a determinant of the specialization pattern. Under certain conditions, it is possible to show that ω and the real exchange rate, defined as $q = P^*E\,/P$, have a negative association: a higher ω implies a lower q. These conditions may include imperfect competition with a variable mark-up factor and imported goods in the workers' consumption basket (Blecker and Setterfield, 2019, pp. 190-191); or a constant mark-up factor and a production function with imported intermediate inputs (see also Appendix 2). A similar conclusion is reached if the relative *real* unit labor costs between center and periphery is taken as an indicator of price competitiveness. The real unit labor cost in the periphery is $RULC^P = \frac{W}{VP}$, where W are nominal wages, P the price level, W/P the real wage, and $V = \frac{Y}{L}$ is labor productivity; the real unit labor cost in the center is $RULC^C = \frac{W^C}{V^C P^C}$. Defining the wage share in GDP as $\omega = \frac{WL}{PY}$, it is straightforward that the real unit labor cost equals the wage share. Therefore, the periphery-center relative real unit labor cost is the inverse of the periphery-center wage share $RRULC = \omega/\omega^C$. If ω^C is exogenous (which is true if the periphery is a small country), then it is possible to work with ω in equation (4) as a satisfactory proxy for the periphery's price competitiveness. The higher is ω, the lower is price competitiveness.

The effect of ω on exports is sector-specific. It is more relevant in the case of labor-intensive sectors than in the case of high-tech sectors, where non-price competitiveness is the critical competitive advantage (empirical evidence is provided, among others, by Dosi et al, 2015, Palazzo and Rapetti, 2017, and Magacho et al, 2021). In developing economies that are in a process of export diversification in manufacturing, the impact of the real exchange rate on diversification can be very important: by changing the export and import baskets, price competitiveness interacts with non-price competitiveness, especially in the presence of hysteresis phenomena (Palazzo, 2024; Porcile et al, 2023 a). The existence of an industrial policy supporting a competitive exchange rate is crucial for having this positive outcome (Oreiro, 2020).

The impacts of q and ω may give rise to another nonlinearity (not formally explored in this section). A low ω, associated with high inequality, compromises non-price competitiveness because of a negative impact on A (absorptive capabilities). Evans and Heller (2015), Onaran et al (2022) and Setterfield (2023) stress the key importance of a "social infrastructure" to encourage human capabilities and productivity in the long run, including care services and policies to prevent all forms of discrimination. These authors reinforce a point made by Katzenstein (1985), namely that a strong social protection network in a world of open economies and rapid technological change is a public good with positive effects on investment and technological diffusion. According to Evans and Heller, in these conditions a developmental state should pursue a "Senian" approach stressing human capabilities rather than reducing relative wages. A policy that aims at lowering ω to boost competitiveness may be a self-defeating strategy when technological knowledge is a key competitive asset. For simplicity, in the rest of the paper, and in accordance with the evidence provided by the empirical literature, it will be assumed that the negative impact of a rise in ω on price competitiveness prevails over the positive impact on absorptive capabilities, and hence the net effect implies $f'(\omega) < 0$.

Equation (4) translates price and non-price competitiveness into the long-run rate of growth with equilibrium in the external sector (i.e. the current account is in a balanced path[4]). In this section the focus will be on the role of absorptive capabilities and green capabilities in defining growth and emissions (economic and environmental sustainability), while in the next section the role of unit labor costs is addressed, along with the social dimension of sustainable development.

[4] Other definitions of external equilibrium may be adopted, including long-term capital flows or a stable external debt to GDP ratio. In this paper the simplest definition is adopted, based on the equilibrium of the current account.

Figure 1: A simple technology-gap model of sustainable development: from green capabilities to GDP and emissions growth

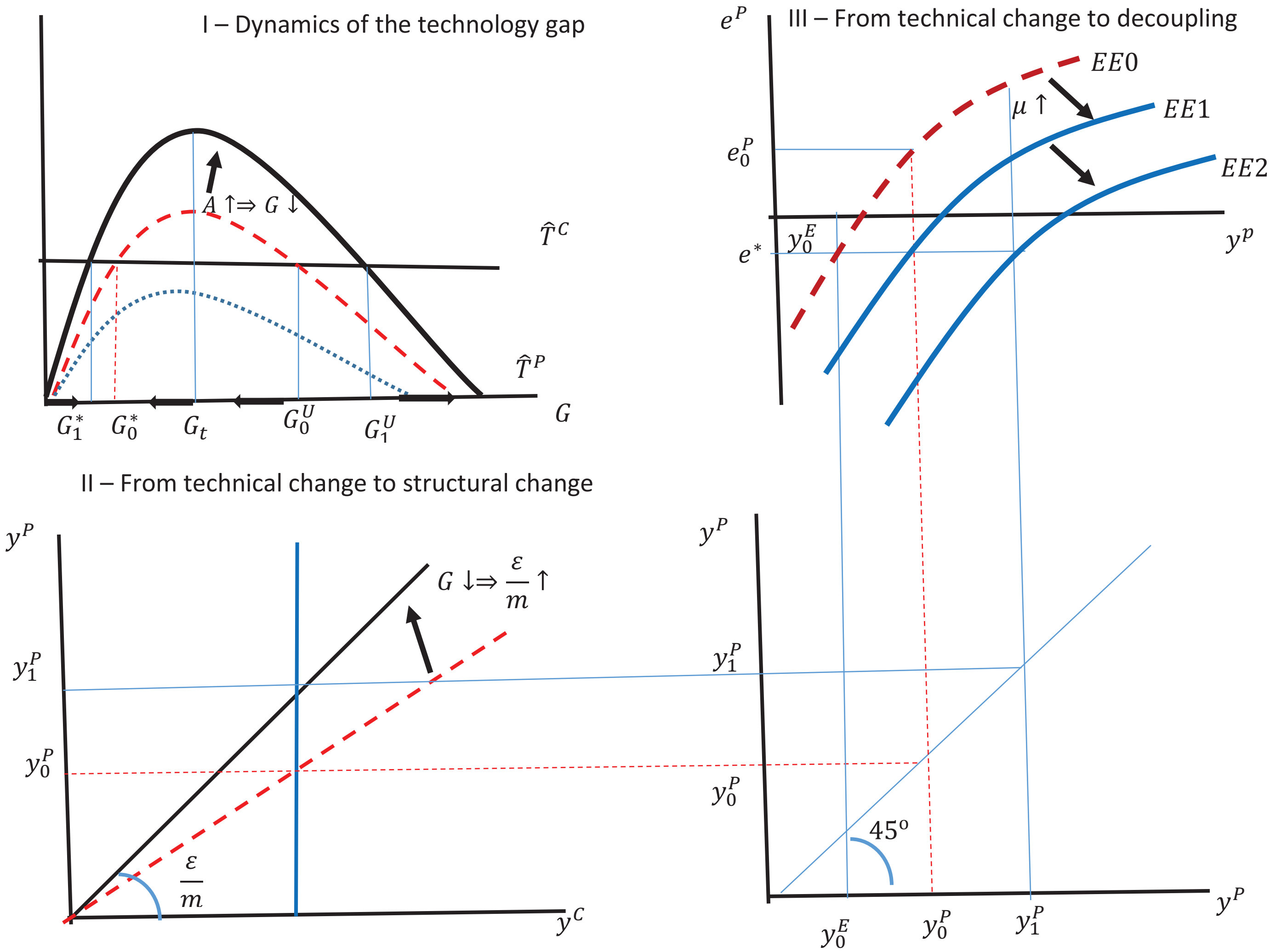

Figure 1 represents a positive shock in capabilities (say, higher investments of education or a more active industrial policy). It shows how a fall in G (quadrant I) associated with a rise in A increases the ratio between the income elasticity of exports and imports and the equilibrium rate of growth (quadrant II). Both y^P and G are in their long-run equilibrium values—which in the case of G, as mentioned, is a function of absorptive capabilities A.

1.3. The direction of technical change and the environmental gap

This subsection extends the model to include the environmental impacts of economic growth. As mentioned, environmentally sustainability is part of the concept of sustainable development, along with social inclusion and external equilibrium. While the concern with the environment is an old one in the Structuralist tradition (Sánchez et al, 2019), it has received increasing attention in recent years (see ECLAC 2020). In particular, the problem of climate change has become central in the discussion of development policies and international economic negotiations.

To discuss the environmental implications of different growth path, Equation (5) translates growth and technological capabilities into the rate of growth of CO2 emissions:

(5) $e = E(y^P(\mu, A), \mu A), \qquad E'(y^P) > 0, y'(\mu) > 0, y'(A) > 0, E'(\mu) < 0, E'(A) < 0, e'(A) > 0, e'(\mu) < 0$

The growth rate of C02 emissions (e) is used as a proxy for the impact of growth on the environment, but it is necessary to keep in mind that such an impact is much more extensive than climate change, including the destruction of the global commons, biodiversity, soils and forests. Quadrant III (Northeast) in figure 1 shows that emissions growth is a monotonically increasing function of GDP growth and a negative function of green technological change in the periphery, which depends on μ (the proportion of the absorptive capabilities that are "green") and A (total stock of absorptive capabilities). A rise in μ and A moves the emissions curve to the left, which lowers the growth of emissions for the same rate of GDP growth.

Note that a rise in μ and A have two types of effects. One is to increase competitiveness and economic growth, and hence emissions (rebound effect); and the other is to reduce emissions per unit of GDP (due to higher green technological capabilities). It will be assumed that if A increases for a given μ, the rebound effect exceeds the effect of the rise in capabilities; on the other hand, if the economy raises μ for a given A, then the emission-reduction effect of technical change prevails over the growth effect. Formally $y^{'}(A)E^{'}(y^P) > \mu E'(A)$ and $y^{'}(\mu)E^{'}(y^P) < E^{'}(\mu)A$. Under these conditions, to keep constant the rate of emissions a higher μ is necessary when A increases —the slope of the iso-CO2 emissions curve, $dA/d\mu$, is positive).

This is illustrated in figure 1. Assume the periphery sets for itself (in accordance with the Paris Agreements of the COP-UNFCC)[5] a commitment to reduce the growth of emissions to a target $e^* < 0$, as defined by its National Determined Contributions (NDCs). If the periphery grows at the rate y_0^P, using the existing technology it will be emitting $e_0^P > e^*$. On the other hand, if the periphery prioritize the e^* goal, for given green technological capabilities, it cannot grow beyond y_0^E. In other words, what figure 1 shows is that the long-run equilibrium rate of growth of the periphery y_0^P (with the existing technology) is too high to be compatible with the NDCs rate of growth of emissions ($y_0^P > y_0^E$). In order to make $y_0^P = y_0^E$ it is necessary to rise μ in such a way that newly created green capabilities allow for drastically reducing emissions per unit of GDP growth. In figure 1, a rise in μ moves the emission-GDP growth schedule from EEO curve to $EE1$ so as to make $e = e^*$ when the periphery grows at y_0^P.

ECLAC (2020) calls the difference between y_0^P and y_0^E in figure 1 the environmental gap. More generally, if the rate of growth consistent with emissions growth e^* is y^E and y^P is the effective rate of growth, then the environmental gap is $y^P - y^E$ (see also Althouse et al, 2020 and Porcile et al, 2023b). Closing the environmental gap requires technological policies and structural change towards renewables and green technologies that shift the EE schedule to the right.

What would be the emissions scenario if there is a rise in A with no changes in μ? The periphery will be growing at a still higher rate of growth (y_1^P) with external equilibrium, but with emissions beyond the NDCs. The environmental gap increases in this scenario. On the other hand, if there is a rise in μ that compensates the rise in A, then the EE curve shifts further to the right, from $EE1$ to $EE2$. Such a shift makes compatible the new rate of growth with the desired contraction of emissions, closing the

[5] COP-UNFCCC stands for Conference of the Parties of the United Nations Framework Convention on Climate Change.

environmental gap ($e = e^{*}$when $y^{P} = y_{1}^{P}$). The change in A and EE may come from changes in green technological capabilities, in the set of goods and services produced, in the social norms and patterns of consumption, or from a combination of all these forces. There is a pair of values $\mu = \mu^{E}, A = A^{E}$, given ω and y^{C}, that satisfies the condition $e^{*} = E\{f[G^{*}(A^{E}), \mu^{E}, \omega]y^{C}, \mu^{E}A^{E}\}$ required for environmental sustainability.

2. Employment, social inclusion and the political economy of sustainable development

2.1. Social inclusion and the three conditions for sustainable development

Although there is no clear-cut definition of what inclusive growth means, in this section it will be defined as a growth path associated with equality and with overcoming the "truncated" welfare state that characterizes the periphery (Holland, 2018). Structural heterogeneity, underemployment, fragmented labor markets, and dualism are concepts that point out towards the existence of a large labor surplus that cannot find formal employment in sectors of increasing productivity in developing economies. Inclusive growth requires absorbing the labor force in jobs with social protection, access to public goods and a "fair income", as defined by the OIT (Ghai, 2003). Formally, the rate of growth of employment in the periphery, $\hat{L}$, equals the rate of growth of the economy minus the rate of growth of labor productivity $v = \dot{V}/V$.

(6) $\hat{L} = y^{P} - v$

We assume that the growth of labor productivity is a function of labor-saving technical change, which in turn depends (a) positively on the share of absorptive capabilities A that are not directed towards green innovation, namely $(1-\mu)A$; and (b) positively on the real cost of labor, $RULC$ (Carnevali et al, 2020).

(7) $v = v[(1-\mu)A, \omega], v'(A) > 0, v'(\mu) < 0, v'(\omega) > 0$

The positive association of labor productivity growth with "brown" absorptive capabilities, $1-\mu$, assumes that green innovation focus mainly on energy or CO2 efficiency rather than on saving labor. The positive association with the real cost of labor, in turn, is part of Sylos-Labini's productivity equation, that asserts that higher labor cost encourage labor-saving innovations. Using (4) and (7) in (6) gives:

(8) $\hat{L} = y^{P} - v = f(G^{*}(A), \mu, \omega)y^{C} - v[(1-\mu)A, \omega]$

Equation (8) states that the large labor reserve army which is underemployed in the (mostly informal/subsistence) low-productivity sector provides a steady supply of labor to the higher-productivity sectors that offer decent jobs in the periphery. As a result, $\hat{L}$ is endogenous and adjusts in response to the demand for labor.

As it is generally accepted in Post-Keynesian and Structuralists models, income distribution depends on the relative power of capitalists and workers in the labor and product markets. Formally:

(9) $\omega = \omega(\hat{L}, \emptyset), \omega'(\hat{L}) > 0, \omega'(\emptyset) > 0$

Equation (9) states that the wage share ω responds positively to two forces. One is the velocity with which labor is demanded in the "modern" sector, $\hat{L}$, which helps the bargaining power of workers in the labor market. The other are social conventions regarding what is considered a socially acceptable consumption basket for workers ($\emptyset$), embedded in a set of institutions that offer social protection, monetary transfers and other forms of income redistribution that promote equality.

The value of ω represents a short- or medium-term political equilibria in a highly unequal society. This equilibrium is most likely to be inconsistent with social inclusion and highly vulnerable to external and domestic (political and economic) shocks[6]. The wage share compatible with an inclusive path is defined as $\omega = \omega^S$, which, as mentioned, takes into consideration critical aspects of equality and sense of participation in a democratic society. This target wage share requires to be attained a specific combination of growth of labor demand and institutions that satisfy the condition $\omega^S = \omega(L^S, \emptyset^S)$. Different combinations of growth and (before and after taxes) redistribution can give rise to the same ω^S: the more egalitarian are the institutions in the periphery (the higher is $\emptyset$), the lower the rate of growth necessary for satisfying the inclusiveness condition.

Now all the elements for a Structuralist definition of sustainable development path are in place. Such a part should simultaneously comply with the following conditions:

(10)$y^P = f[G^*(A^E), \mu^E, \omega^S]y^C$
(11) $e^* = E(y^P, \mu^E A^E)$
(12) $\omega^S = \omega(\hat{L}^S, \emptyset^S)$

Equation (10) ensures that the economy grows with external equilibrium and satisfies Thirlwall's Law; equation (11) ensures that the emissions rate is the one promised in the NDCs for that rate of growth; equation (12) implies the growth path is not only economically (per equation 10) and environmentally (per equation 11) sustainable, but also socially sustainable. Usually, growth (y^P) is the indicator of success most recognized by the governments. With the concept of sustainable development, ω^S and e^* instead of y^P are the indicators of success, being y^P just a tool in the quest for improving the other indicators (Jackson and Victor, 2020).

In other words, absorptive capabilities at A^E and the share of green capabilities at μ^E should at the same time fulfil the international competitiveness condition of equation (10) and the reduction of emissions condition of equation (11); social protection at $\emptyset^S$ and the growth of decent jobs at $\hat{L}^S$ are combined to make $\omega = \omega^S$ as in equation (12). These are extremely challenging conditions. Except in the case of the BOP-constrained rate of growth (where structural and financial asymmetries converge to prevent the economy from getting too far apart from equilibrium in current account), there is no automatic political or economic forces that can guarantee these combinations of parameters; no price mechanism can spontaneously produce such results. Moving in the correct direction is therefore a process intensive in political negotiations, trial and errors in economic policy. It also implies deploying in a convergent way a very broad set of policies, in particular industrial and technological with social and education policies. The distribution of power among the various actors involved is central to define what outcome will prevail. In particular, the functions $f(\cdot)$, $E(\cdot)$ and $v(\cdot)$ are driven by processes of learning and technological change whose rules and timing are hard to predict or control, while the function $\omega(\cdot)$ depends on political and social processes that are no less complex and uncertain. The potential scope of results is therefore fairly broad and open. Some possible scenarios are discussed in the next sub-section.

2.2. Growth paths and political economy

Including social and political conflicts in the analysis of economic development has strong roots in the Latin American Structuralist tradition. The work of Cardoso and Faletto (1979) on dependency and the

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[6] A major analysis of democratic breaks and transitions is O'Donnell et al (1991). A model within a Structuralist framework is Porcile and Sánchez-Ancochea (2021)

concept of “styles of development” (vg. Sunkel and Giglo, 1980; Fajnzylber, 1990) foreshadow the more recent literature on “varieties of capitalism” and “growth models” (Pérez Caldentey and Vernengo, 2022; Stockhammer, 2023). A key Post Keynesian reference is Bhaduri and Marglin (1990).

For the analysis that follows I drew heavily on Guarini et al (2023) and Alatorre et al (2023). Let’s assume there are three social groups that bargain over the key parameters of the model: the educated bourgeoisie (see Gatti 2020) that supports green innovation (the greens, G), the brown bourgeoisie whose interests are in carbon-intensive industries (the browns, B), and workers (the reds, R) that aim at maximizing the wage share and social protection)[7]. These actors enter into various type of alliances, whose outcomes are summarized in Table 1. The scenarios represent “directions” or “trends” in growth paths, not steady states, as they are pervaded by uncertainty and depend (as mentioned) on a changing political economy. In the same vein, each social group is heterogeneous. Technocrats in the state and international organizations may play an important role with the Greens. More generally, middle-income actors may be relevant in the three groups, even though they are not workers or bourgeois (of any type) strictly speaking.

[7] Note that Greens, Reds and Browns do not necessarily represent actual political parties, but a coalescence of interests around certain objectives (the environment, income distribution, and growth based on carbon-intensive goods).

Table 1. Political coalitions and growth path scenarios

Political coalition	Parameters of the model		
	A	μ	ω
GR: sustainable development	$A = A^E$	$\mu = \mu^S$	$\omega = \omega^S$
BR: inclusive carbon-intensive growth	$A^B < A^E$	$\mu < \mu^S$	$\omega = \omega^S$
GB: non-inclusive “green” growth	$A = A^E$	$\mu = \mu^S$	$\omega < \omega^S$

An alliance between the educated bourgeoisie and workers (GR scenario) illustrates the kind of political coalition required by a strategy of sustainable development: the Greens put pressure to set A and μ in accordance with the environmental goals (A^E, μ^S), while the Reds push for social protection and welfare (ω^S). The possibility of having a self-sustained growth path based on this alliance depends on the relative importance of price and non-price competitiveness in exports, the demand for labor in the new leading sectors (renewables, digital economy, caring economy, circular economy, to name some of them) , the scope for positive interactions between Senian social policies and technical change, and the capacity of an “entrepreneur state” to invest and attract private investments in green technologies (Mazzucato, 2013). Education on the consequences of environmental destruction critically helps the GR coalition to gain political support (Dávila-Fernandez and Sordi, 2020)[8]. In an ideal scenario, these variables would reinforce each other, but it is likely that during the transition the fiscal deficit and the external deficit run high, out of a surge in green and social investments. As a result, what the literature calls a “just transition” may be derailed at a very early stage, unless there is international support in the shape of a “Global Keynesian New Deal“ (Hein and Truger, 2012) or a “Green New Deal”(UNCTAD, 2016).

The BR scenario combines growth based on carbon-intensive goods with income redistribution —not necessarily of the innovation-enhancing kind. The actors of this coalition to a large extent perceive environmental sustainability as a luxury they are unwilling or unable to pay for. Employment growth is key, as well as redistribution after taxes and transfers if growth is not labor intensive. Such a growth path is highly dependent on commodity exports whose rents are often used in a clientelistic manner to buy political legitimacy.

The BR growth path is extremely vulnerable to external shocks, which may bring about major economic and political disruptions. In effect, a commodity-dependent economy is prone to conflict because actors negotiate income shares in a zero-sum game, i.e. they dispute how to redistribute “Ricardian rents” derived from the exploration of natural resources. The ownership, taxation and governance of these

[8] The Dávila-Fernández-Sordi model discusses the diffusion of pro-environment sentiments in general, based on the interactions among actors with different preferences, the “strength of infection regarding sentiments towards the environment” and different initial conditions. In the framework of the model presented above, their model can be interpreted as one that makes “education” endogenous, in such a way that the very size and political power of the educated bourgeoisie evolve and may give rise to different equilibrium positions.

resources (which provide static comparative advantages in international trade) dominate the policy agenda (Nochteff, 1996). This is in contrast with negotiations in a diversified economy, which tends to focus on how to boost cooperation across various actors in different sectors in order to take full advantage of their complementary skills and assets (some of which are dedicated or specific to certain industries, which provides further incentives for long-run coordination). This cooperation is necessary to sustain systemic or "authentic" competitiveness that leads to the creation of "Schumpeterian rents" arising from technical change. The political scientist Ian Shapiro has argued that: *"the diversification of the economy matters more than inequality, and perhaps even as much as per capita income [for the stability of democracy]. What counts is the extent to which everyone's eggs are in the same basket"* (Dahl and Shapiro, 2015, p. 198).

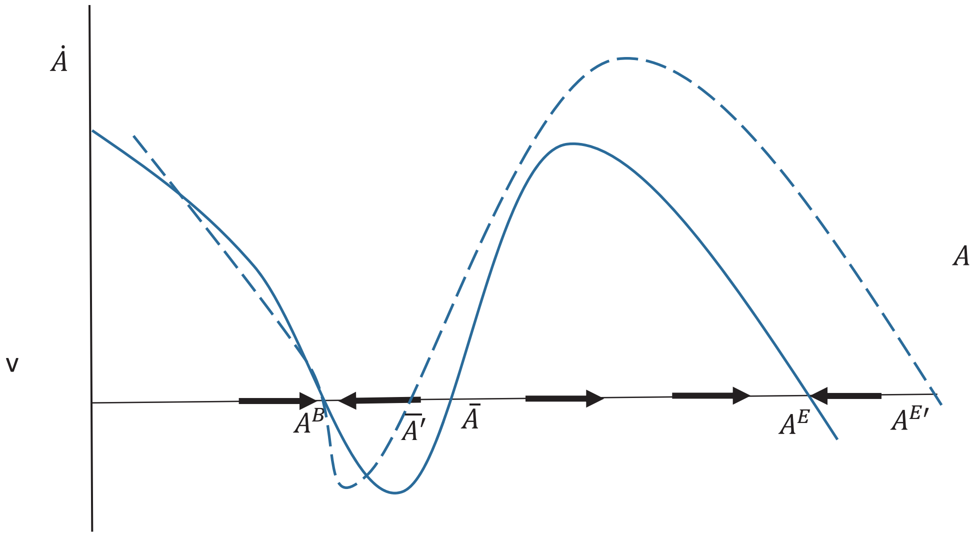
Even an uneasy alliance between Greens and Browns is possible. if the Greens seek to expand the resources allocated to green capabilities at the expense of those allocated to social protection, while the Browns seek to increase international competitiveness through lower wages and (to a lesser extent) the "greening" of production processes. In some cases, these two in principle opposed segments of the bourgeoisie have a common interest in weakening social protection to finance green projects and reduce unit labor costs. At the same time, they expect that employment growth would keep workers' discontent at bay. The economic and political viability of this growth path increases if exports are elastic to price competitiveness, if the greening of the economy affects positively exports, if unions are weak, and if growth is labor-intensive and employment growth compensates for the low wage share in GDP.

Last but not least, financial globalization looms large over all these political coalitions, especially the GR. The veto power of a highly mobile financial capital can put in check the fiscal and social measures required to sustain growth and /or industrial and technological policies. Taming the destabilizing effects of short-term capital flows and "vigilant" bonds is therefore a necessary complement to sustainable development policies (Erten et al, 2021).

2.3. From the middle-income trap to sustainable development

Multiple equilibria may emerge from the interactions among political power, absorptive capabilities and political power. The graph in figure 2 shows changes in absorptive capabilities over time ($\dot{A}$) as a function of the existing capabilities, $\dot{A} = h(A)$. It therefore aims to represent a long-term scenario in which institutions change reflecting changes in political coalitions.

Figure 2. Multiple equilibria and absorptive capabilities



Let's assume an initial scenario of an economy with poor absorptive capabilities, a high technology gap and, as a result, highly dependent on low-tech, carbon-intensive exports. The Greens will have little to offer, except perhaps promises of a better future; the Reds will be weak and probably —as mentioned— more interested in redistributing rents than in technical change. Machiavelli's warning will be totally valid, that "there is nothing more difficult … than to take the lead of the introduction of a new order of things". The equilibrium level of capabilities will be at A^B, that desired by the brown capitalists, with some degree of income redistribution when commodity prices are high. Any attempt to move A towards the right of A^B will encounter political en economic forces that move the economy back to the brown equilibrium A^B. This is in line with the argument of Doner and Ross-Schneider (2016) about the political roots of the middle-income trap.

Still, if the adoption of industrial and technological policies allows absorptive capabilities to surpass the critical level $\bar{A}$, then increasing returns will reorientate the economy towards a new stable equilibrium at A^E, the level consistent with a sustainable growth path. Structural change will support a more dynamic export drive, relying on green technical change and non-price competitiveness. As the economy diversifies, new economic and political interests (more favorable to sustainable development) arise. The educated bourgeoisie gains political influence, while technical change boosts the creation of formal jobs and the demand for skilled labor, favoring the unionization of workers and the expansion of social protection. Stronger unions and formal labor markets strengthen the hand of workers in bargaining for social policies. In figure 2 it is assumed that the complementarities between green innovation and welfare provisions allow for increasing returns in learning and the building of new capabilities; after some time, decreasing returns set in leading to a stable equilibrium at A^E[9].

[9] The story does not need, however, that decreasing returns prevail at some point. The model may generate a persistent increase in A on time, matched by a similar increase in other countries.

However, attaining this virtuous scenario is conditional on a sharp rise in green capabilities, beyond the stable equilibrium A^B and critical capabilities $\bar{A}$. A rise in μ, and positive feed-backs with ω, may shift the $h(A)$ curve to the right. This is represented by the dotted line in Figure 2. The range of A values for which increasing returns prevail increases. With a higher μ, the self-sustained (albeit not spontaneous) transition towards A^E starts at a lower value of $\bar{A}' < \bar{A}$. At the same time, the new equilibrium level of green capabilities, $A^{E\prime}$, will be higher than before—and so will the degree of technological intensity of the economy.

Concluding remarks

This paper discussed recent advances in center-periphery models with a focus on the conditions for sustainable development in its three dimensions (economic, social and environmental). These conditions are presented within a single, articulated framework that helps discuss potential complementarities and trade-offs between the objectives of sustainable development. The model is policy-friendly: it allows for a broader, interdisciplinary discussion of how social, industrial and technological policies can be deployed to produce the desired path.

Except for the external constraint, there is no endogenous forces that could lead to sustainable development. The role of politics and political negotiations (at the domestic and international levels) is paramount. Different paths would emerge as political power and structural change co-evolve and create tensions and disequilibria. These growth paths are represented as ideal "types" that arise from different combinations of the parameters of the model, which in turn reflect a certain constellation of political forces. Positive feed-backs between political power and economic power may lead to a development trap which could only be overcome by a major exogenous investment shock that advances (human and productive) capabilities beyond a critical level.

Political forces are represented in the model in the form of three different coalitions, which come out of various possible alliances between the educated bourgeoisie (G), the workers (W) and fossil-intensive producers (B). A BR alliance will be viable and successful when the commodity lottery is favorable, but end in revolt when export prices falter, especially because the workers are the weakest bond that will most likely endure most of the adjustment costs. A GR coalition is viable if succeeds in producing a major effort at technical change and building green capabilities, along with a "Senian" approach towards social protection and equality. While this path offers prospects for having a stable inclusive path in a democratic setting in the long run, the transitional phase will be defied by major sort-run imbalances in the fiscal policy and the external sector that may lead to the demise of the GR coalition. A domestic "bigh push for sustainability" combined with new rules for international cooperation (a Global Green New Deal) are necessary conditions for a successful transition. These conditions, however, have become less likely to be obtained in a context of growing political polarization and geopolitical rivalry.

Appendix 1. Sustainable development in a multigoods setting

The model presented in this work can be easily reframed as a multigoods model along the lines of Dosi et al (1990) and Basilio et al (2019). This appendix gives an illustration of the potential that the multigoods model offers for discussing sustainable development.

Assume there is a large number of goods produced in the international economy, from $z = 0$ to $z = 1$. Labor is the only factor of production and wages the only income; hence total income in the country is $w^i L^i$, where i is either P (periphery) or C (center) and L^i total employment in country i. All goods enter in the same proportion in the consumption basket of workers in both countries. Some additional assumptions are the following:

First, all goods are ranked as an increasing function of technological intensity. The higher is z, the more technology-intensive is the production of the good (*i.e* higher technological capabilities are necessary to produce the good $z + 1$ than z).

Second, the productivity ratio between the periphery and the center, $a_z = a_z^P / a_z^C$, is a monotonically decreasing function of the good's technology technological intensity (blue curve in figure A.I): the higher z, the lower is a^P / a^C.

Third, relative wages $w = \frac{w^P}{w^C}$ increases with the number of goods produced in the periphery (red curve). The higher is z, the higher is GDP in the periphery, the higher the demand for labor and the higher are relative wages (red curve in figure A.I).

How is determined the number of goods produced in the periphery in equilibrium, z^*? In an open international economy, this number is simultaneously determined by the relative periphery-center wages and relative center-periphery labor productivity. The periphery will produce all those goods for which relative wages are lower than relative productivity (where the red and blue curves intersect in figure A.I).

Once the pattern of specialization of the periphery is found (i.e. the number z^*), then the relative center-periphery GDP is determined assuming equilibrium in the trade balance. Such equilibrium requires that what is spent in the periphery in goods of the center $(1 - z^*)$ equals what the center buys from the periphery (z^*):

$$\text{(A.1.1)} \quad w^C L^C z^* = w^P L^P (1 - z^*)$$

Therefore, making $w^i L^i = Y^i$:

$$\text{(A.1.2)} \quad \frac{Y^P}{Y^C} = \frac{z^*}{1 - z^*}$$

Taking logs and differentiating with respect to time:

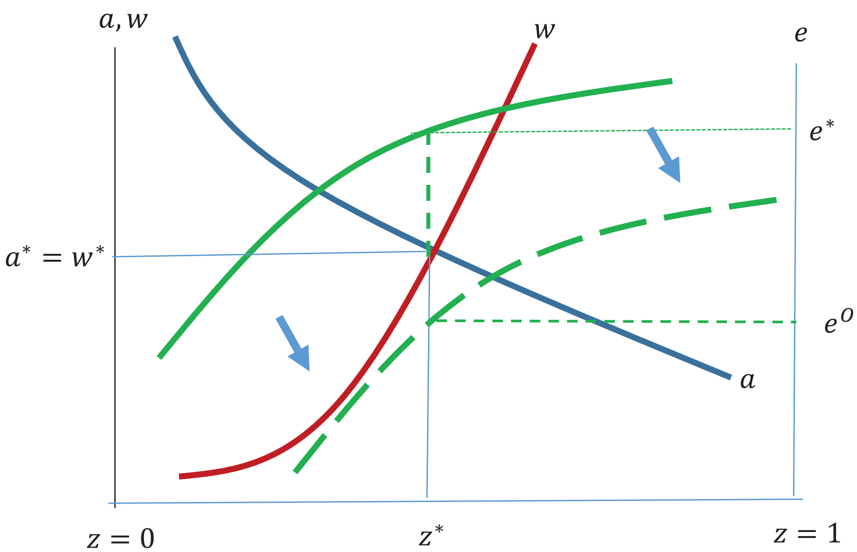
$$\text{(A.1.3)} \; y^P - y^C = \frac{\hat{z}}{1 - z}$$

A fall in relative wages in the periphery has an ambiguous effect on its income. It allows for expanding exports and employment, but the loss in the terms of trade may more than compensate the positive effect on GDP. On the other hand, a rise in relative productivity associated to a fall in the center-periphery technology gap produces an unambiguous positive effect on the relative income of the periphery (see Dosi et al, 1990, p. 225).

Having Y^P determined, it is possible to find emissions, for a given technology. Emissions E increases with the GDP but a declining rate (green curve, vertical axis of the right): the higher is z^*, the higher is GDP in the periphery and the higher are emissions (although emissions per unit of GDP falls).

Sustainable development would require to change the emission function, the relative wage function and the productivity gap function to attain a certain desired levels of emissions, a desired GDP ratio or a desired income distribution. For instance: in equilibrium emissions are e^* but technological and industrial policies would be necessary to bring it to e^O (shift of the green curve to the right); in equilibrium relative wages are w^*, but a strong social policy is required to shift the curve of relative wages to the left and ensure a higher relative wages for all possible specialization patterns (i.e. a higher w for a given z).

Figure A.I: Emissions, productivity and wages in the multigoods model with technical change towards green innovations



Appendix 2. The inverse relationship between the wage share and the real exchange rate

With a constant mark-up, the inverse relationship between the real exchange rate and the wage share may come from the use of imported inputs in the production process.

Price in imperfect competition is formed based on a mark-up rule:

(A.2.1.) $P = z(\frac{W}{a} + \frac{P^*eM}{b})$

where z is the mark-up, W are nominal wages, a is labor productivity, P^* is the price of imported goods, e the nominal exchange rate (for simplicity $e = 1$), M total imported intermediate goods and b the productivity of imported intermediate goods.

It is necessary to distinguish between GDP (Y) and total product (X), since total product includes imported intermediate inputs which are not part of the GDP, i.e.

(A.2.2) $Y = PX - P^* M$

The share of profits in total product (π^T) is:

(A.2.3.) $\pi^T = \frac{PX - WL - P^*M}{PX}$

Recall that the productivity of imported inputs is $b = X/M$ and labor productivity $a = X/L$. Hence $M = X/b$ and $L = X/a$, and therefore:

(A.2.4.) $\pi^T = 1 - \frac{W\left(\frac{X}{a}\right) + P^*\left(\frac{X}{b}\right)}{PX} = 1 - X\frac{(W/a + P^*/b)}{PX}$

Using the price equation A.2.1 in A.2.3. and A.2.4 gives:

(A.2.5.) $\pi^T = 1 - \frac{wb}{z(Wb + P^*Ea)} - \frac{P^*Eab}{z(Wb + P^*Ea)} = \frac{(Wb + P^*Ea)(z-1)}{(Wb + P^*Ea)z} = \frac{(z-1)}{z}$

The profit share in total product depends entirely of the monopoly power of capitalists as captured by z.

What about the share of profits in GDP? As mentioned GDP is total product minus the intermediate inputs as in equation A.2):

(A.2.6.) $Y = PX - P^*M = PX - \frac{P^*X}{b} = PX\left(1 - \frac{P^*}{Pb}\right) = PX\,(1 - \frac{q}{b})$

where q is the real exchange rate as $q = \frac{P^*}{P}$ (recall that e, the nominal exchange rate, is 1). Therefore, the share of profits in GDP is:

(A.2.7) $\pi = \frac{PY - WL}{PY} = \frac{PX - P^*M - wL}{PX\left(1 - \frac{q}{b}\right)} = \frac{\pi^T}{1 - \frac{q}{b}}$

Since per equation (A.2.5) we know that $\pi^T = \frac{z-1}{z}$, then the share of profits in GDP increases with the monopoly power of the capitalists and the real exchange rate. Correspondingly, the share of wages in GDP, which is $1 - \pi$, falls when the monopoly power of capitalists increases and the real exchange rate increases. Given z, there is a negative association between the wage share and the real exchange rate.

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