New Directions in Latin America Structuralism

26th FMM Conference, Berlin, 22-24 October 2022

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Abstract

The concept of sustainable development implies not only reducing the gap in GDP per capita between center and periphery, but also requires that this should be attained with growing equality and respecting the limits of the planet. In this paper we discuss sustainable development by defining three rates of growth: the minimum required to end poverty (y^S); the maximum compatible with external equilibrium (y^T); the maximum compatible with a global carbon budget (y^L). We estimate these three rates of growth for Latin America and found out that $y^S > y^T > y^L$. We argue that a combination of industrial and technological policies, along with income redistribution and the extension of social protection, are necessary for having $y^S = y^T = y^L$, which defines the sustainable development path. We set forth a simple model in which traditional demand-side determinants of long-run growth (the external constraint) are combined with a supply-side dynamics driven by technical change. We emphasize that technical change may adopt different directions, namely rising labor productivity or rising environmental efficiency, which in turn may lead to different scenarios in terms on growth, employment, emissions and income distribution.

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Introduction

Latin American Structuralism (LAS) is part of the core of heterodox thinking on economic development. In this paper we focus on LAS advances in the field of sustainable development, and discusses its implications for economic policy and the political economy of development.

It is first necessary to define what we understand by LAS. We argue that the backbone of LAS is the center-periphery theory, namely the idea that the international system is fundamentally asymmetric in three dimensions. First, it is asymmetric in technological and productive capabilities, due to the what Prebisch called the "slow and unequal diffusion of technology" at a global level. Second, it is asymmetric in the financial sphere as the periphery occupies a subordinated position in the hierarchy of currencies (Paula, Fritz, 2017). Last but not least, is asymmetric from the point of view of power relations in the international system, as it has very little sway in the definition of the rules of the game governing the system. In this paper we focus on technological asymmetries and its implications for growth and income distribution.

The paper is in 4 sections, besides the introduction and the concluding remarks. Section 1 presents the basic ECLAC center-periphery model; section discusses 2 the need to expand the model so as to include the concepts of social en environmental equilibrium, along with external equilibrium; section 3 offers an analytical framework which articulates the three equilibria in the form of three rates of economic growth; section 4 presents some empirical evidence for Latin America about the magnitude of the gaps. It is argued that closing the gaps requires a combination of strong social policies and income redistribution, along with technological policies with a focus on innovation and diffusion of green technologies.

1. The original model and the crucial role of structural change

LAS combines insights from the Schumpeterian tradition in the fields of technological innovation and diffusion with the demand-led growth models of the Keynesian tradition. One way of looking at LAS is as a theory of divergence between two regions based on increasing returns to technological learning and the impact of technology on the pattern of specialization. We begin with the canonical BOP-constrained growth equation (Thirlwall's Law) and see how it can be interpreted from a LAS perspective:

$$(1)\ y^T = \frac{\varepsilon}{m} y^W + (|\alpha + \beta| - 1)\hat{q}\ ,$$

where y^T is the rate of economic growth that keeps the current account in equilibrium, ε is the income elasticity of exports, m the income elasticity of imports, y^W is the rate of growth of the rest of the world, $\alpha < 0$ is the price elasticity of exports, $\beta < 0$ is the price elasticity of imports, and $\hat{q}$ is the rate of growth of the real exchange rate ($q = P^W E/P$ hence $\hat{q} = \hat{P}^W + \hat{E} - \hat{P}$), where P represents domestic prices, E the nominal exchange rate (the price of the foreign currency in units of the domestic currency), and P^W represents foreign prices. A thorough review of this type of models can be found in Blecker and Setterfield (2019, chapter 9) and Blecker (2022).

We take on board the usual assumption that in the long run the real exchange rate is stable and hence $\hat{q} = 0$, which gives:

$$(2)\ y^T = \frac{\varepsilon}{m} y^W$$

What the model states is that the rate of growth of exports of goods and services should equal the rate of growth of imports, $\varepsilon y^* = my^T$. Otherwise, the need of external loans would grow over time to a point in which lending to the country would be considered too risky, and hence international lenders stop financing the country. If elasticities are given and growth in the rest of the world is exogenous (which is a reasonable assumption if the periphery is a small open economy), then the rate of growth of the periphery must vary to satisfy equation (1) to prevent an explosive explosion of the external debt. Short-term fluctuations and cycles may occur around the trend, particularly as a result of cycles of international liquidity in a financialized global economy (see Botta, 2021, and Kohler and Stockhammer (2022)). These fluctuations may in some cases may give rise to hysteresis effects. However, we will ignore these complications of the model and focus on equation (1) as a good predictor of the long-run rate of economic growth.

Convergence, i.e. reducing the GDP per capita gap between center and periphery (abstracting from differences in population growth in the two poles of the system) requires:

$$(3)\ \frac{y^T}{y^W} > 1 \Leftrightarrow \left(\frac{\varepsilon}{m}\right) > 1$$

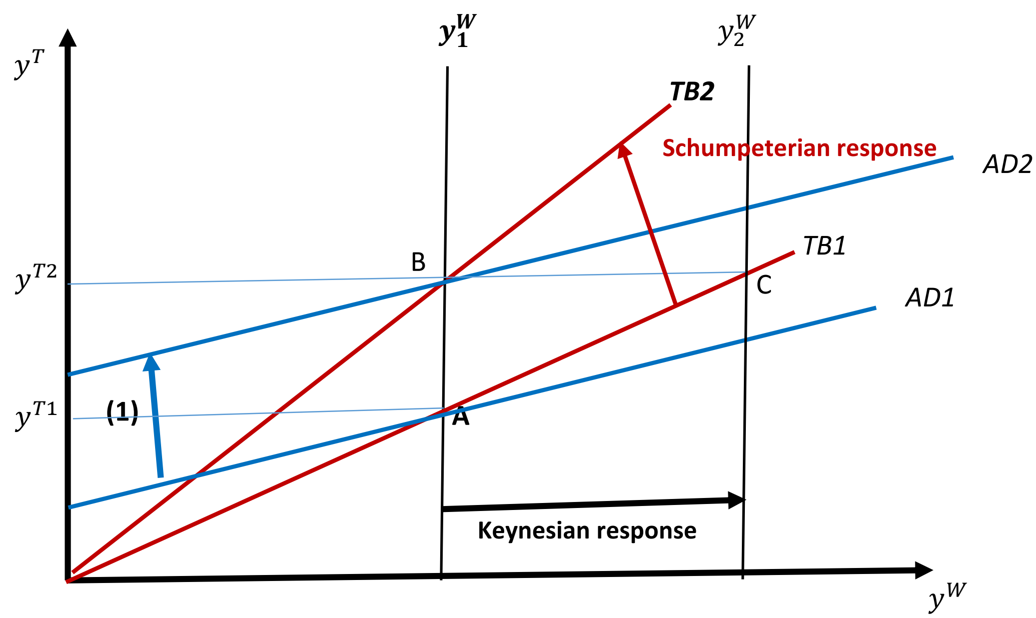
Two asymmetries are critical to interpret this equation from a center-periphery standpoint. First, technological and productive asymmetries that are reflected in the pattern of specialization and shape the elasticity ratio ε/m. These asymmetries explain why the periphery specializes in exports from low-tech sectors whose demand is relatively weak in the international economy; for the same reason, the periphery is highly dependent on high-tech imports from the center, whose demand grows at a very fast rate with the rise of domestic income. In other words, the pattern of specialization of the periphery implies a low ε as compared to m and hence $\frac{\varepsilon}{m} < 1$. As a result, it falls behind the center in terms of economic growth, as stated in equation (3).

The implication of this perspective is that structural change (reshaping the pattern of specialization and hence the income elasticity ratio) is key for redefining the position of the periphery in the international system. This is illustrated in figure 1. The TB schedule gives the rate of growth of the periphery with external equilibrium for each rate of growth of the center. The slope of this schedule is the income elasticity ratio (ε/m). The AD schedule is a conventional, Keynesian aggregate demand curve that gives the effective rate of growth, where the intercept is given by those components of aggregate demand that do not depended on exports. The initial equilibrium position is point A in which TB cuts the exogenous rate of growth of the center y_1^W. If autonomous expenditure in the periphery increases (for instance through a more expansive fiscal policy or a better income redistribution in a wage-led economy), shifting the AD curve from AD1 to AD2, a trade deficit emerges.

This deficit can only be corrected by either structural change or by a rise in the rate of growth of the center. Structural change redefines the slope of the TB curve, a change in (ε/m) that moves TB1 to TB2, and renders a new equilibrium rate of growth at B. Alternatively, an increase in the rate of growth of the center from y_1^W to y_2^W renders a new equilibrium rate of growth for the periphery at C.

Point B corresponds to a pattern of specialization that is at the same time more diversified and more technology intensive. It reflects a more sophisticated set of skills and capabilities in the periphery associated with a reduction of the center-periphery technology gap (Fagerberg and Verspagen, 2002; Cimoli and Porcile, 2010; Ribeiro et al., 2017). Point C, on the other hand, comes out of a coordinated expansion of aggregate demand at center and periphery. The rise in the demand of imports of the center matches the rise in the demand of imports of the periphery due to the increase in the rate of growth of the periphery. We will call the shift in TB the Schumpeterian response (point B), and the increase in the rate of growth of the center the Keynesian response (point C) to external imbalances. While both responses allow the periphery to grow faster (at y^{T2} in points B and C instead of y^{E1} at point A), only the Schumpeterian response implies convergence in the sense that $y^{T2} > y^{W}$. Figure 1 assumes that the change from TB1 to TB2 makes $\frac{\varepsilon}{m} > 1$.

Figure 1. The key role of structural change for convergence



Key for the graph. Step (1) is the initial expansion of aggregate effective demand in the periphery; the Keynesian response is the increase in growth in the center, from y_1^W to y_2^W, which renders a new equilibrium at C; (3) the Schumpeterian response is based on technological catching up and structural change in the periphery, which redners a new equilibrium at B. The TB-schedule is growth with external equilibrium in the periphery; AD: effective aggregate demand in the periphery.

A second asymmetry which is critical for this result is the subordinated position of the periphery in the hierarchy of currencies. If the AD curve shifts from AD1 to AD2 but neither the TB schedule nor growth in the center change, then in point B a trade deficit emerges. The periphery will have to issue a debt in foreign currency (the so-called "original sin") because the currency of the periphery is not accepted to settle international transactions. The periphery will have to allocate part of its export earnings to service or repaid the debt instead of using them to import the capital and intermediate goods it needs to accelerate growth. The external constraint becomes a binding constraint on growth by an interplay of three factors, i) lack of access to imports which are essential for growth, ii) debt or currency crises that may lead to a sudden stop in lending (which in turn triggers a recession) and iii) depressing the animal spirit of private investors or the ability of the government to rise public investment. The result is the well-known contractionary bias embedded in the way that the international economy corrects trade imbalances—a point noted by Keynes in the Bretton Woods negotiations of 1944, when he argued in favor of penalizing the accumulation of trade surpluses.

Two important points should be stressed. The first is that the income elasticity ratio can vary with the adoption of industrial and technological policies that reshape incentives in favor of sectors with higher technological intensity and higher income elasticity of the demand for exports. Specialization is not fate but the outcome of certain set of policies, which in turn reflects a constellation of interests and power. The supply side story of LAS finds a perfect match in the evolutionary theory of technical change that started with the pioneering work of Nelson and Winter (1982), among others (see Dosi et al, 2022; Spinola 2020; Lee, 2013). The evolutionary theory of technical change can be seen as the microfoundations of the LAS macro story of divergence in the international system (Porcile, 2019).

Specifically, the evolutionary theory of technical change explains why technological backwardness can perists due to increasing returns, path dependence, and lock in phenomena in learning, impressing a strong inertia on the pattern of specialization. Tacitness in skills and capabilities imply that technology cannot just be purchased off-the-shelf to reduce the distance with respect to the international technological frontier. What a country can produce efficiently depends on what it produced in the past. Strong path-dependence may give rise to slow-learning, slow-growth traps, endogenously reproduced by market forces. Industrial policy is crucial to escape from this trap—which is why the supply side story of LAS is necessarily an evolutionary story, not a neoclassical one.

A second key point is that having a (evolutionary) supply side story does not mean that the model is not demand-led or that Thirlwall's Law no longer holds. The keystone for a central role of effective demand in explaining long-run growth is that technical change, structural change and productivity growth can only affect the long-run equilibrium rate of growth by changing two demand-side parameters, namely the income elasticity of exports and the income elasticity of imports. To put it in a more straightforward way: no supply-side change can affect economic growth directly, but its impact has to be mediated by changes in effective demand. In a system with a hierarchy of currencies, the behavior of external demand is crucial. This result is reinforced by the possibility of positive feed-backs between learning, international competitiveness and the expansion of the external markets, as will be suggested in the simple model presented in section 3.

2. Social equilibrium and environmental sustainability

There are endogenous forces in the market system and in the existing (domestic and global) institutional framework that makes the BOP constraint the binding constraint on economic growth in the periphery —and hence impose y^T as the equilibrium solution in the market. Economic agents cannot ignore this constraint, which is incorporated to expectations and decisions regarding new investments and production in the face of trade unbalances.

But there are other constraints that are not incorporated to the expectations and calculus of the economic agents because they are externalities that cannot be solved by uncoordinated private decisions. Inequality and CO2 emissions produce negative externalities that operate as constraints on development in the long run. Inequality creates a political economy that threatens political stability and the ability of private and public agents to uphold institutions conducive for growth and innovation. In the same way, the costs of environmental destruction are a canonical example of externalities not duly considered in private decisions over what goods and services to produce, and what processes to adopt. In both cases, there are no market forces working to correct the grave effects that either the escalation of political conflict or environmental destruction produce on welfare and the prospects of peaceful development. Industrial and technological policies are required along with a “developmental” role for the State (Khan and Blankenburg, 2019; Evans and Heller, 2019;).

The concept of sustainable development offers a normative framework that combines the economic, social and environmental dimensions. Economic growth should go hand in hand with changes in the patterns of consumption and production that make it compatible with the environmental limits of the planet. At the same time, such patterns should ensure increasing levels of equality and the eradication of poverty. Social and environmental goals are at the core of the concept sustainable development, along with the quest for rising levels of income per capita (ECLAC, 2020).

How can these three dimensions can be put together in an analytical framework that allows for discussing their interactions in a more rigorous way? Within the LAS tradition it can be suggested a three-gap model based on three rates of growth: the one with external equilibrium y^T, which represents economic sustainability for the periphery; the rate of growth required for social sustainability y^S, which is the one compatible with growing equality in the economy; and the rate of growth that respects the ecological limits of the planet, y^L. The determinants of y^T has been already discussed, so we now focus on defining y^S and y^L.

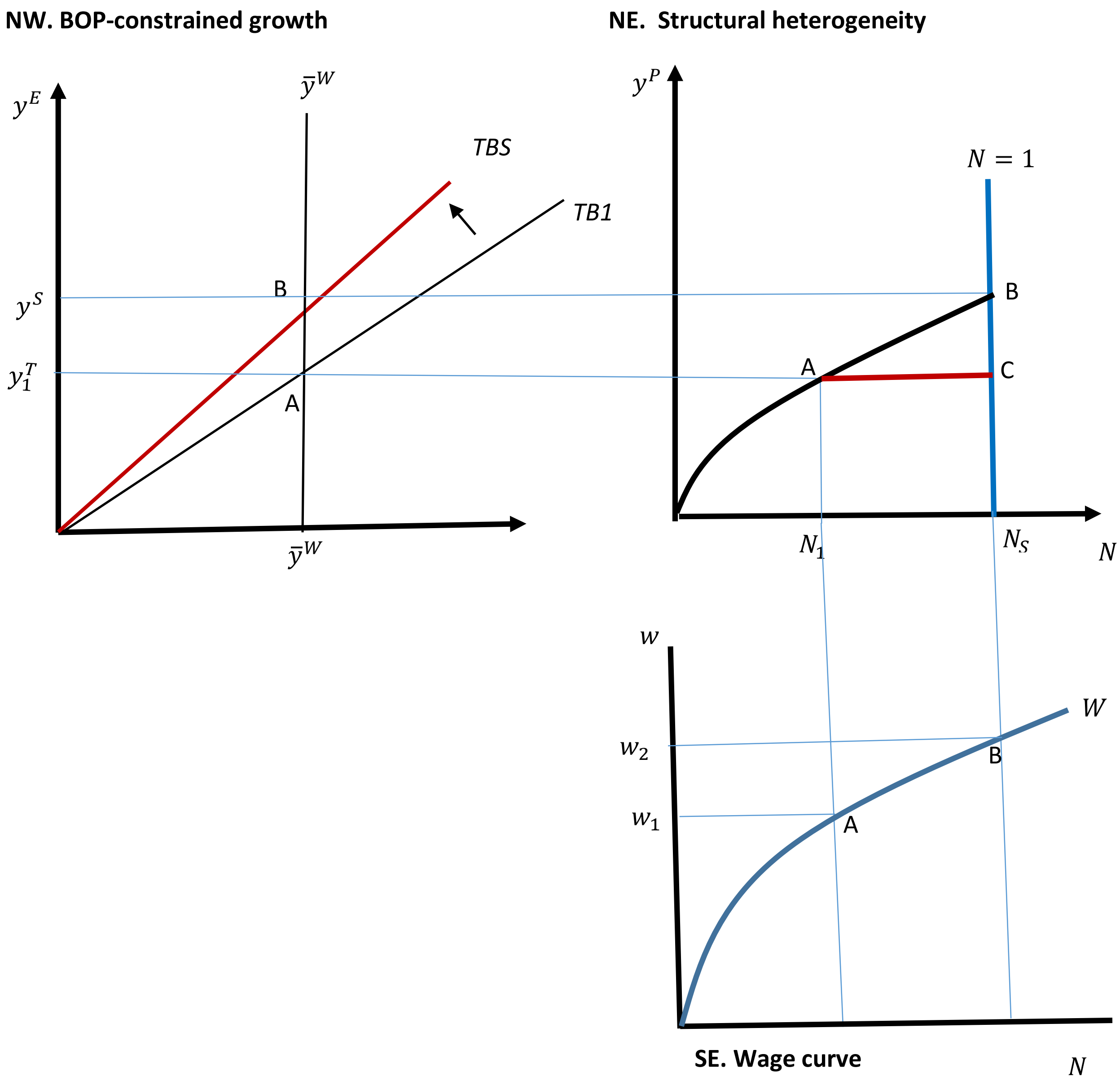
Social sustainability

Patterns of specialization carry strong distributional implications (Hartman et al., 2017). LAS has argued that peripheral economies are characterized by “structural heterogeneity”, meaning that differences in labor productivity within the production structure of the periphery are very high. A simple way of approaching this is to see the periphery labor market as dual, with a large informal sector of workers allocated in activities of very low productivity. Figure 2 offers a graphical representation of structural heterogeneity and how it is related to the pattern of specialization. The figure contains three panels. Panel NW reproduces figure 1, the combination of rates of growth of center and periphery that keeps the current account in equilibrium. Panel NE translate the production structure into a certain employment structure in the periphery, in particular, in the share of formal employment as compared to that of underemployment / informality. The distance AC is a measure of structural heterogeneity (informality) in the periphery. For simplicity, we use the terms “underemployment” and “informal jobs” as equivalent. Panel SW can be seen as an expression of the wage curve in the periphery: real wages depend positively on the share of formal employment in the periphery.

We start with structural change in the periphery in panel NW, which shifts the TB schedule from TB1 to TB2 stemming from a rise in ε/m. Workers move from underemployment to the higher-productivity formal jobs created by the diversification of the economy. Structural change is the engine that absorbs the labor surplus of the peripheral economy.

The new equilibrium rate of growth raises formal employment in panel NE, from N_1 to N_S as more workers find jobs in the new, more dynamic sectors created by structural change. The shrink of the informal sector, rising real wages and more sophisticated skills favor income redistribution in favor of labor. A higher share of formal employment implies that more workers have access to labor rights and social benefits, with a positive effect on unionization and bargaining power. This redistribution of income and power is captured in panel SE, where real wages respond positively to higher levels of employment (see Oreiro et al., 2022). Positive feed-backs may exist between wage share and productivity growth, not analyzed in this paper (see on this Storm and Naastepad, 2012; Fontanari and Palumbo, 2022)

Figure 2. Structural change, employment and real wages



The rate of growth of social equilibrium is a normative concept. There is no clear-cut definition for y^S, except that it should allow for growing equality and the incorporation of the unemployed to formal labor markets at a rate that ensures political and social stability in the context of political democracy[1]. For simplicity we will assume that y^S is the one that produces zero underemployment/informality in the periphery (which is the same as assuming that there is full employment in the formal sector). Keeping in mind the Kaleckian “curse” that full employment cannot be obtained in a capitalist economy for political reasons, $N_S = 1$ should not be interpreted *ipsis litteris* but as a useful simplification that captures the idea that equality and inclusion are central to sustainable development.

In sum, the distance between N_1 and N_S is a measure of structural heterogeneity (the share of workers in low-productivity, informal jobs); closing this distance demands a rate of growth y^S which in turn can only be sustained over time if there is a transformation of the pattern of specialization that makes y^T converge to y^S.

Environmental sustainability

Current patterns of growth and consumption compromise the capacity of the planet to sustain life and endangers the welfare of present and future generations. The loss of biodiversity, the amount of hazardous chemicals and toxic waste released in the air, seas and soil, and greenhouse gas emissions (GHE) leading to climate change, are examples of the destructive impact of human action on nature. We use GHE as a proxy for these various forms of environmental destruction, while keeping in mind this is a very imperfect proxy, which fails to capture some very important threats to life in the planet, such as at the loss of biodiversity.

The rate of GHE depends, on the one hand, on the rate of economic growth, since growth demands energy, part of which supplied with fossil fuels. On the other hand, it depends on the technological efforts directed at reducing carbon emissions per unit of GDP. Such reduction depends on changes in the energy matrix or changes in the efficiency of energy consumption. Technology drives the fall in GHE in both cases.

The environmental constraint on growth can be represented by a carbon budget, which is the maximum level of GHE compatible with preventing the temperature of the earth from rising above 1,5°C (the critical level identified by the science of climate change). From a center-periphery standpoint, the problem is thus how to allocate the carbon budget: the higher the rate of growth of the center, less of the carbon budget is left for the periphery, and the lower will be the rate of growth of the periphery compatible with environmental sustainability. Inversely, technical change that reduce GHE per unit of GDP expands the carbon budget and hence the potential rate of growth with environmental sustainability that can be attained by the periphery given the rate of growth of the center.

Following Althouse et al. (2020) end ECLAC (2020), assume that x is the rate of growth of the efficiency in GHE (units of GDP per unit of greenhouse emissions) that must be attained at a global level to keep the earth temperature below 2°C. We define the center-periphery environmental frontier (CPEF) as the combinations of the rates of growth in the center (y^W) and growth in the periphery (y^L) that are consistent with a reduction of emissions equal to x. Formally:

[1] The higher the share of informality in total employment and the weaker the institutions for income distribution and social protection, the higher will be y^S, the rate of growth require for inclusion, and social and political stability in democracy.

$$(4)\ y^L = \frac{1}{a}\left[\left(\underbrace{z^C - x}_{A}\right) + a\left(\underbrace{z^P - z^C}_{B}\right) - \underbrace{(1-a)y^W}_{C}\right]$$

In equation (4) y^L is the rate of growth of the periphery compatible with environmental sustainability. The higher is the rate of growth in the center, the lower is y^L. The intercept of the curve depends on the rate of growth of GHE efficiency due to green technical change in the center (z^C) and the periphery (z^P), weighted by the share of the periphery in global GHE (α). The impact of green innovations in the center is captured by the term ($z^C - x$), which is the rate of growth of GHE in the center as compared with the target (the ceiling of 1,5°C), and the term ($z^P - z^C$), which is the velocity with which the periphery catches up with green technological change in the center (the change in the technology gap of the periphery with respect to the environmental technological frontier). Assuming that the center is the technological leader, if $z^P > z^C$, then technical change is faster in the periphery, which represents catching up in green technologies; if $z^P < z^C$, there is technological divergence in favor of the center, as the periphery lags behind the green technological frontier.

3. The three gaps of sustainable development: a simple model

The three gaps

We will argue that the rate of growth required for social equilibrium in the periphery is higher than the rate of growth consistent with external equilibrium, while the latter is higher than the one compatible with environmental sustainability, i.e. $y^S > y^T > y^L$. These inequalities yield three gaps: the social gap ($y^S - y^T$), which is the difference between the required rate of growth for social equilibrium and that compatible with external equilibrium; the environmental gap ($y^T - y^L$), which is the difference between the BOP-constrained rate of growth and the one that respects the environmental limits of the planet; and the sustainable development gap, which is the sum of both gaps, ($y^S - y^L$). An economy can be considered to be moving along a sustainable development path if and only if it is true that the equality $y^S = y^T = y^L$ is satisfied and the three gaps are closed in the long run.

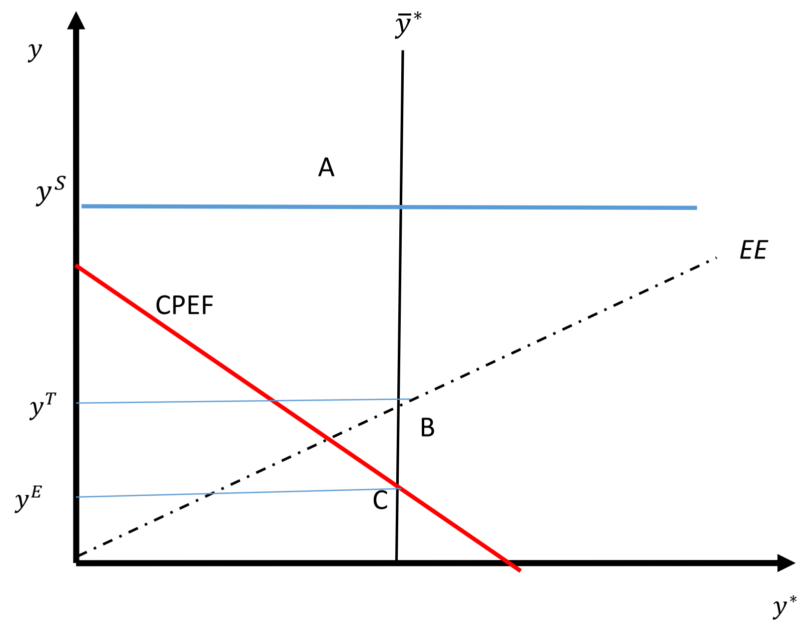
In the periphery, the highest of the three rates of growth is the one required for social equilibrium, y^S. This is the result of the high initial levels of inequality, high levels of poverty and the large share of informal (underemployed) workers in the labor market. The pattern of specialization of the periphery, heavily concentrated in low-tech sectors, make y^T systematically below y^S. A the same time—in spite of y^T being lower than what is needed to curb underemployment—current patterns of growth and consumption are unsustainable from an environmental point of view. Even the relatively low levels of growth in equilibrium associated with a low income elasticity ratio (ε/m), is higher than y^L if there is no significant decoupling from GHE and GDP growth.

In other words, the combination of poverty and informality, low levels of diversification and technological capabilities, and patterns of production and consumption, gives rise to a scenario in the periphery in which $y^S > y^T > y^L$. This also means that sustainable development (the equality the three rates of growth) requires them converging to y^S.

Of the three rates of growth (y^T, y^S, y^L), only y^T is the endogenous result of market forces in trade and financing. Deficits in current account and the rise of the external debt do not allow the periphery to drift too far apart from y^T. On the other hand, there are no market forces working in favor of social or environmental equilibrium. What Rodrick (2013) calls hyperglobalization has rather tended to heighten inequality and environmental degradation in most countries. Therefore, the equality between the three rates of growth can only be attained through public policies that modify the intensity and direction of technical change, and measures to redistribute income in favor of labor.

Figure 1 presents the "business as usual" scenario, which reinforces international asymmetries. The curve TB gives the rate of growth with external equilibrium for each value of the rate of growth of the center (TB in figure 1); the curve CPEF is the center-periphery environmental frontier, that gives the rate of growth of the periphery required for reducing GHE at the rate x for each rate of growth in the center; and the horizontal line gives the rate of growth for social equilibrium (see appendix 1). The center grows at an exogenous rate $\bar{y}^W$. The distance between the rates of growth at points A and B is the social gap, while the distance between B and C is the environmental gap. The distance between A and C gives the total gap for sustainable development.

Figura 3. Three gaps in sustainable development



y^T: rate of growth with external equilibrium
y^L: rate of growth which for environmental sustainability
y^S: rate of growth for social equilibrium
AB social gap; BC environmental gap; AC gap of sustainable development

We can imagine a scenario in which the center heightens its efforts at green innovation. Those efforts will shift the CPEF to the right. But if there is no technological diffusion to the periphery, the shift will be weaker than it would had been with a reduction of the technology gap. In addition, if the periphery losses competitiveness in the process, y^T may fall and the social gap would increase. This scenario is an incentive for the periphery to try to accelerate growth without considering its impact on the environment.

A simple model

Assume that the total labor force in the periphery is constant and equal to 1. Increases in formal employment therefore directly translates into a fall in the share of underemployed labor. Throughout the analysis we will assume that the economy has a very large reservoir of labor in the informal sector (underemployment, hence $0 < N \ll 1$). The rate of growth of formal employment ($\widehat{N}$) equals in the long run the BOP-constrained rate of growth (y^T) minus the rate of growth of labor productivity (a):

$$(5)\ \widehat{N} = y^T - a.$$

Technical change plays two roles. One is to increase labor productivity; the other is to raise the efficiency in the use of energy and deploying new technologies for energy production based on renewable sources. The relative importance of these two impacts of technical change depend on the direction of investments in R&D. We assume that this direction can be changed by policy decisions which are exogenous to the model.

Technical change and labor productivity: learning by doing

Let's look first at the impact of technical change on labor productivity. We assume—in line with the Keynesian tradition—a modified Kaldorian function of technical change based on dynamic increasing returns. For simplicity, we specify the technical change function as linear in N and y^T.

$$(6)\ a = g_0 + g_1 y^T + g_2 N$$

The productivity regime is Kaldorian because labor productivity increases with the rate of growth of the economy y^T (learning by doing), $g_1 > 0$; but it is a modified Kaldorian regime because there is an additional variable in the argument of the technical change function, which is employment in the formal sector, N. As N increases and less workers are underemployed, the economy becomes more diversified and sophisticated; positive externalities stemming from technological innovation and diffusion rise, which accelerates productivity growth, $g_2 > 0$.

We can rewrite equation (5) as:

$$(7)\ \widehat{N} = \frac{\varepsilon}{m} y^W (1 - g_1) - g_0 - g_2 N$$

And therefore in equilibrium:

$$(8)\ N = \frac{\left[\frac{\varepsilon}{m} y^W (1 - g_1) - g_0\right]}{g_2}$$

The critical role of effective demand in increasing formal employment comes directly from equation (8). The employment level in equilibrium responds positively to growth in the center and to a rise in the income elasticity ratio, and negatively to a rise in the learning parameters of the economy related to labor productivity. Two important caveats are needed. First, we assume that real wages increase pari passu with productivity growth and hence unit labor costs are not changing due to labor-saving technical change. Second, there are no spillovers of technology form labor-saving to demand-expanding technical change —i.e. neither international competitiveness nor export diversification are affected by the growth of labor productivity. The second assumption is consistent with the first assumption (constant unit labor costs) and with the simple version of the BOP-constrained growth model, in which growth depends solely on the income elasticity ratio (ε/m).

Green technical change: the green technology gap

The second role of technical change is to increase the efficiency in the use of energy per unit of output. This increase weakens the impact of economic growth on GHE. We assume—as argued in the evolutionary tradition—that the potential for the diffusion of green technologies from center to periphery is a positive function of the stock of green technologies available in the center as compared to that in the periphery. This means that the potential diffusion of technology to the periphery increases with the green technology gap, which we proxied by the energy productivity gap, $Z = Z^C/Z^P$, where Z^C is units of GDP per unit of GHE in the center and Z^P is the same variable in the periphery. Taking logs and differentiating with respect to time it is straightforward that $z = z^C - z^P$, where small letters are proportional rates of growth (i.e. the rate of change of the energy productivity gap is $z \equiv \dot{Z}/Z = z^C - z^P$). We will use "green technology gap" and "energy productivity gap" as synonymous.

Formally, the center–periphery green technology gap evolves as follows:

$$(9)\ z = f(Z), f_Z < 0$$

The function $f(Z)$ falls monotonically with the size of the green technology gap. Economies that are far apart from the green technological frontier learns faster than those that are closer to it because they have a backlog of innovations to imitate. Still, the potential for imitative learning only becomes effective when there are domestic efforts and institutions devoted to capacity-building in these technologies. Better institutions for learning in the periphery (what Freeman, 2004, called "technological infrastructure) implies a lower value of Z in equilibrium (a fall in the green technology gap).

The diffusion of green technology does not only affect emissions. It also changes the production structure and the (ε/m) ratio. Several factors concur to explain why. First, a green transition requires changing the energy matrix, new inputs, and redefining production processes, which in turn reshape the production matrix. In other words, a green transition entails a profound transformation of the production structure. Second, higher energy productivity may help new sectors of the economy to become competitive and export to the global markets. Third, patterns of consumption are changing out of a growing awareness of climate change. Consumers are changing their preferences in favor of greener goods and services, while governments impose new regulations in international trade that penalize carbon-intensive goods. As a result, a fall in Z produces a positive effect on structural change and the international competitiveness of the periphery, which begins to export a broader set of goods to the center, or replace brown imports by greener domestic production.

We capture the impact of reducing the technology gap in green technologies (green transition) on international competitiveness by assuming that there is a rise in the income elasticity of exports of the periphery, $\varepsilon(Z), \varepsilon_Z < 0$. A lower Z means a higher ε/m and a higher BOP-constrained growth y^T. Therefore:

$$(10) \qquad y^T = \left[\frac{\varepsilon(Z)}{m}\right] y^W$$

Using equation (10) in (8):

$$(11) \qquad \widehat{N} = \left[\frac{\varepsilon(Z)}{m}\right] y^W (1 - g_1) - g_0 - g_2 N$$

The demand of workers in the formal labor market continues to depend on global growth but now it also depends (negatively) on the green technology gap. Labor-saving technical change reduces the demand of labor under the assumption of no technological spillover between the two types (labor-saving and energy-saving) of technical change. In this (somewhat extreme) version of the model only green innovations affect growth. This has to do with the fact that a) that the model is demand-led and technical change can only affect growth if it affects the demand parameters; and b) there are two types of technical change on the supply side, and only green technical change does have an impact on demand elasticities.

Equilibrium and stability

Equations (11) and (9) form a system of differential equations where the state variables are N and Z. The Jacobian of the system is:

$$(12) \qquad J = \begin{vmatrix} -g_2 & \left[\frac{\varepsilon(Z)}{m}\right] y^W(1-g_1) \\ 0 & f_Z \end{vmatrix}$$

The trace is negative (since $g_2 > 0$ and $f_Z < 0$) and the determinant $(-g_2 f_Z)$ is positive, hence the equilibrium solution is stable.

We are interested in two changes in the value of the parameters of the dynamic model. The first is a change in policy that accelerates the diffusion of green technologies in the periphery and reduces the green technology gap in equilibrium, as in figure 1A. The gap falls from Z_1 to Z_2. This change may come out of a reallocation of resources towards R&D in green technology and / or the adoption of a new regulatory framework in favor of low-carbon production processes and goods.

The second change is a policy that accelerates labor-saving productivity and hence changes the level of formal employment in equilibrium at each level of GDP. This second case is represented in figure 1B by a downwards shift of the $\widehat{N} = 0$ iscoline.

The results are very different in terms of growth and formal employment. Green technical change impacts international competitiveness and therefore aggregate effective demand, giving rise to a higher level of formal employment in equilibrium (from N_1 to N_2). This in turn reflects a more complex production structure than before the policy change. In the case of labor-saving technical change, as there is no impact of the policy on aggregate demand, there will be a reduction in formal employment, while the green technology gap does not vary.

Figure 1A. Demand-expanding green technical change

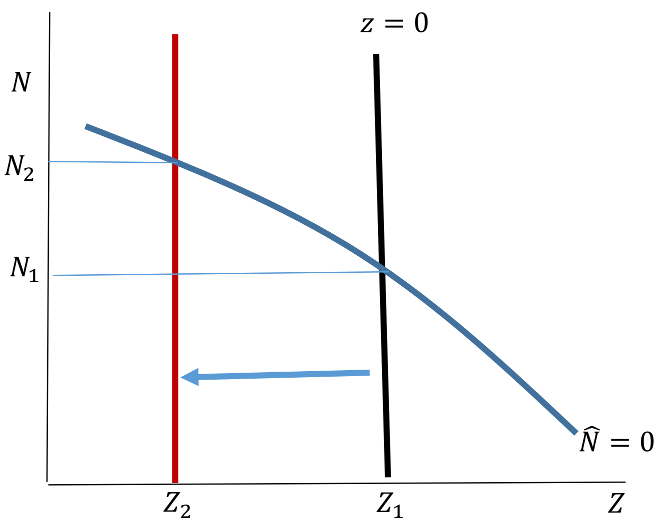
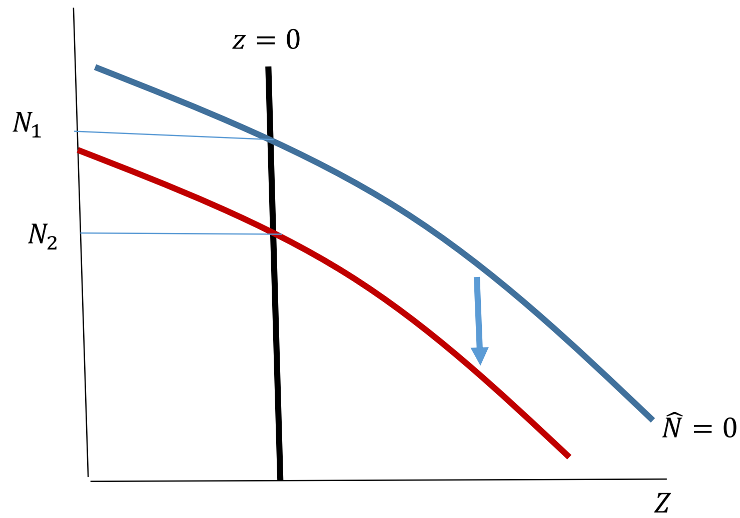


Figure 1B: labor-saving technical change



The assumption that a rise in labor productivity does not favor diversification is—as mentioned—too strong. If the increase in labor productivity has an effect on the income elasticity ratio, then the loss of employment due to a higher labor productivity might be compensated by a rise in economic growth. However, this scenario is not explored in this paper as our focus is on green technical change, decoupling and employment.

The model focuses on Latin America, which is considered the periphery, and the rest of the world, which is considered the center. We acknowledge that the rest of the world contains many peripheral countries, but most of Latin American trade is with the developed world and China. The latter, although it is not a center country strictu sensu (its GDP per capita corresponds to a developing economy), displays a trade pattern with Latin America which is mostly along center – periphery lines (China exports industrial goods and imports goods intensive in natural resources). Therefore, from the perspective of international trade, it is not invalid to consider China among the center countries in a center-periphery setting.

As regards the position of the periphery in the international hierarchy of currencies, the key argument is that the periphery currency is not accepted as a global reserve currency. Therefore, when a trade deficit emerges, the periphery has to contract an external debt denominated in a foreign currency (the so-called "original sin"). The periphery will have to allocate part of its export earnings to service or repaid the debt instead of using them to import the capital and intermediate goods it needs to accelerate growth. Otherwise, the international financial markets will stop lending or refinancing the periphery's debt, with a strong impact on growth. This is how the external constraint becomes a binding constraint on growth, namely by limiting imports which are essential for growth, or through an external debt or currency crisis associated with a sudden stop in lending, which in turn triggers a recession. (Botta, 2021;).

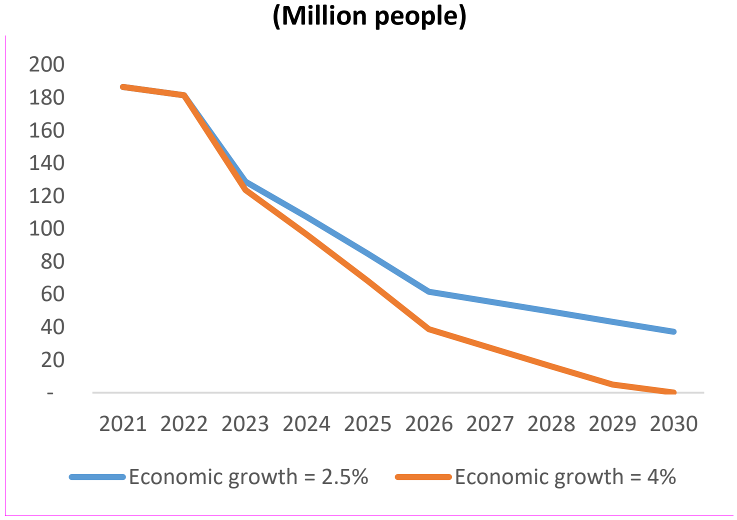
4. A simulation for Latin America

In this section we simulate a growth trajectory for Latin America which combines the three equilibria. First, we present some operative definitions of the equilibrium path (in the economic, social and environmental terms). Subsequently we estimate the size of the existing gaps and provide a rough measure of the effort at income distribution and structural change required to close those gaps. The simulations we will present are updated estimations of those provided by ECLAC (2020) and Samaniego et al (2022).

We argued that all rates of growth should converge to the one with social equilibrium, which is the highest of the three. We will define y^S as the growth that necessary to eradicate poverty in Latin America until 2030. The percentage of people below the poverty line in Latin America was about 33 % in 2022. To end poverty, measures aimed at "pure" income distribution must be combined with measures for the creation of employment. As regards income distribution, we will work with a scenario in which the Latin American societies make a strong commitment with redistribution that consists in taxing the richest 10 % and using this money to transfer an amount equivalent to one monetary poverty line to the poor. The total amount of monetary transfers begins at 1.5 percentage points of the income share of the richest 10 % (who own about 60 % of total income in Latin America, according to the World Inequality Lab) in 2023, and then increases 0,5 percentage points every year until reaching 3 percentage points in 2026. Taxes and redistribution remain at the same level thereafter. This is a significant effort at redistribution, but not particularly ambitious. First, it just implies monetary transfers corresponding to one poverty line, which is a rather modest goal in terms of income distribution. Second, it implies reducing the Gini index of the region from grosso modo 0.68 to 0.5, which is the Gini index of Uruguay. This is hardly a radical transformation, although, as mentioned, a significant one in the context of the extremely high levels of inequality that characterized Latin America throughout its history.

The reduction of poverty comes from redistribution but also from the rise of formal employment out of economic growth. Figure 2 shows the number of people expected to be under the poverty line in 2030 assuming different rates of growth in Latin America between 2022 and 2030, always under the assumption that the policy of income redistribution described above is implemented. It can be see that only a rate of growth of at least 4 % leads to an end of poverty in 2030. The growth rate in the region in the period 2014-2019 was extremely slow (just 0,3 % per year) and the estimates for 2022 suggest an annual growth rate of about 1.8 %. In this scenario growth falls short of what is necessary for social equilibrium.

Graph 1. Poverty and growth: estimated number of people in poverty in Latin America in 2030 with income redistribution under two different scenarios of economic growth
(Million people)



Note: Vertical axis: Millions of people; horizontal axis: year

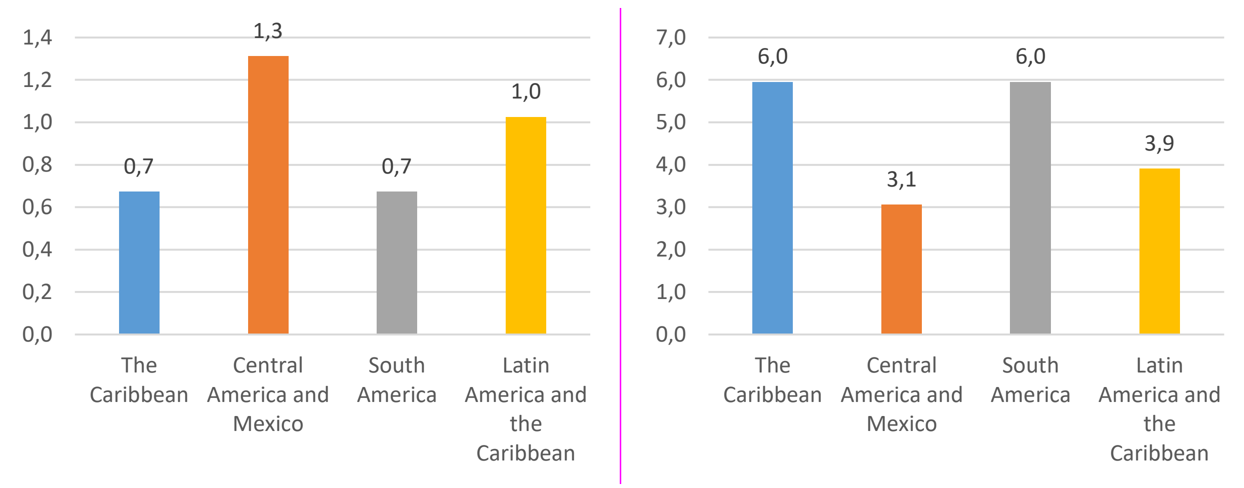
In other words, the rate of growth necessary for social equilibrium is not matched by the expectations of future growth nor by the growth trend of the previous six years before the pandemic. In addition, it is above the BOP-constrained rate of growth (i.e. $y^T < y^S$). This latter rate can be estimated (as argued in the theoretical model) using Thirwall's Law, i.e. by estimating the ratio between the income elasticity of exports and the income elasticity of imports and multiplying this ratio by the expected rate of growth of the global economy until 2030. This exercise should be taken *cum grano salis* since there is a lot of uncertainty about what will happen with growth and new technologies in the next decade. Still, the estimations are useful for at least having a broad indication of how difficult is the task ahead for Latin America to attain sustainable development.

The left panel of graph 2 shows the income elasticity ratio for different subregions of Latin America and the Caribbean; the right panel shows the rate of growth of the global economy that would be necessary for attaining the 4 % rate of growth in Latin American and the Caribbean if the elasticities do not change. It can be seen that—perhaps with the exemption of Mexico and Central America—the expected rates of growth of the world economy would not allow these countries to attain the social equilibrium rate of growth while at the same time avoiding external imbalances.

Graph 2. Latin America and the Caribbean: is the rate of growth with social equilibrium compatible with the BOP-constrained rate of growth?

Elasticity ratio by subregion

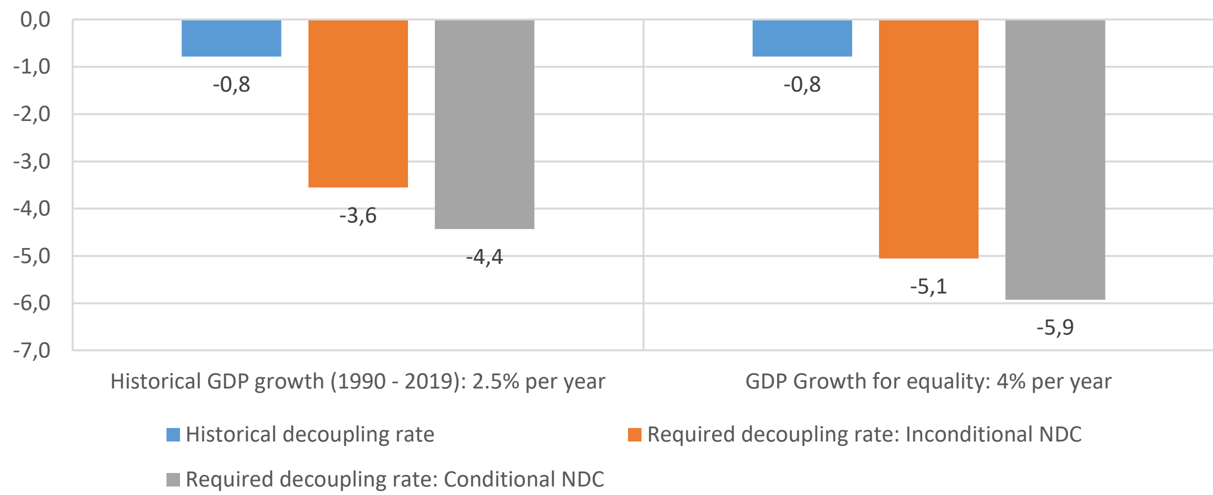
Rate of growth n the rest of the world (y^W) necessary to make $y^T = 4\%$ *(Percentage)*



Last but not least, we look at the evolution of emissions in the region and the level of emissions consistent with environmental equilibrium. While climate change science does provide an indicator of total GHE reductions that represents a target (a desired point on the center-periphery environmental frontier), it cannot determine how the global carbon budget should be distributed among individual countries and regions. Environmental justice should allow developing economies to use more of the carbon budget than the developed economies. But the exact point depends on a process of international negotiations whose outcome depends in turn on the political economy of climate change negotiations.

To overcome the problem of not having a clear target for LAC's GHE, we choose the one that the Latin American countries themselves promised to achieve through their national determined contributions (NDCs). This is the target used for in graph 3, which shows the rate of green technical change (in the shape of decarbonization rates) required to honor the NDCs if the rate of growth continues at its historical pace (panel A) or if the rates of growth equals the necessary for social equilibrium (panel B).

Graph 3: Historical z^p (decoupling or decarbonization rate) and the required rate for two growth scenarios: Historical GDP growth of Latin America and the Caribbean and the rate of growth for social equilibrium (in percentage)



Graph 3 shows that even if the region continues to grow at the extremely low levels of the period 1990-2019, the fall in GHE per unit of GDP, z^p, (-0.8%) would not be enough to attain the least ambitious of the NDC (-3,6 %). Moreover, if the region succeeded in attaining the goal of growing at a least 4 % per year, the effort for decoupling should be more than six times higher than the historical rate of decarbonization.

Concluding Remarks

The challenge of sustainable development is to provide decent jobs and rising living standards in the periphery, while at the same time preventing growth from destroying the environment. We have addressed this problem in a highly simplified way defining three rates of growth: the minimum required to end poverty (y^S); the maximum compatible with external equilibrium (y^T); the maximum compatible with a global carbon budget (y^L). We estimated these three rates of growth for Latin America and found out that $y^S > y^T > y^L$. Our figures are preliminary, but they do provide a quantitative first estimation of the magnitude of the gaps between the social, economic and environmental objectives of sustainable development. This magnitude is as well an indication of the challenges faced ahead by public policy to close these gaps.

An effective response to the three-gap challenge is extremely complex and requires the combination of a broad set of policies and of a new political economy. At the international level, the problems of a just transition to a green economy require strengthening cooperation in technological, financial, and trade issues to reduce the technology gap in green technologies and invest in new sectors. At the domestic level, there are two closely interconnected policies that should be embraced. One is a major effort at reducing inequality and extend social protection, which would allow growth to have a stronger impact on the eradication of poverty. The other policy is to encourage domestic investments and institutions for green technologies that boost decarbonization, international competitiveness, and ease the external constraint on growth.

The political economy conditions necessary for the adoption of these policies, however, are notably absent and this moment and indeed appear to be increasingly distant in the future. The impacts of geopolitical rivalry, the pandemic, and war have, at least temporarily, compromised the attention that inequality and climate change have gained in the past two decades.

References

Althouse, J., Guarini, G. and Porcile, G. (2020) "Ecological macroeconomics in the open economy: Sustainability, unequal exchange and policy coordination in a center-periphery model", *Ecological Economic*s, 172, 2 March, 106628

Blecker, R. (2022) "New Advances and Controversies in the Framework of Balance-of-Payments-Constrained Growth," *Journal of Economic Surveys*, vol. 36, no. 2 (April 2022), 429–467, https://doi.org/10.1111/joes.12463.

Blecker, R. and Setterfield, M. 2019. *Heterodox Macroeconomics. Models of Demand, Distribution and Growth.* Cheltenham, UK, Edgar Elgar

Botta, A. (2021) – "Financial liberalization, exchange rate dynamics and the financial Dutch disease in developing and emerging economies", in: Bonizzi, B., Kaltenbrunner, A., and R.A. Ramos (eds.) – "Emerging economies and the global financial system. Post-Keynesian analysis", London: Routledge.

Cimoli, M. and Porcile, G. (2010) "Specialization, Wage Bargaining and Technology in a Multigoods Growth Model", *Metroeconomica* 61(1), 2010, pp. 219-238

Dosi, G. Riccio, F. and Virgillito, M.E. (2022) "Specialize or diversify? And in What? Trade composition, quality of specialization, and persistent growth":, *Industrial and Corporate Change*, 2022, 31, March, pp. 301–337

ECLAC/ILO (Economic Commission for Latin America and the Caribbean/International Labour Organization) (2021), "Decent work for platform workers in Latin America", *Employment Situation in Latin America and the Caribbean*, No. 24 (LC/TS.2021/71), Santiago.

ECLAC (2020) "Building a New Future: Transformative Recovery with Equality and Sustainability", Santiago: UN-ECLAC.

Evans, P. and Heller, P. (2019), *The State and Development*, in Deepak Nayyar (ed) *Asian Transformations: An Inquiry into the Development of Nations*. Oxford University Press.

Fagerberg J. and Verspagen B. (2002), "Technology-Gaps, Innovation-Diffusion and Transformation: An Evolutionary Interpretation", *Research Policy*, 31 (8-9), pp. 1291-1304.

Fontanari, C. and A. Palumbo (2022), “Permanent scars: the effects of wages on productivity”, *Working Paper*, No. 187, Institute for New Economic Thinking (INET), July.

Freeman, C. (2004). “Technological infrastructure and international competitiveness”*, Industrial and Corporate Change, 13(3), 541–569.* doi:10.1093/icc/dth022.

Hartmann, D, Guevara, M. R., Jara-Figueroa, C., Aristarán, M., & Hidalgo, C. A. (2017) “Linking economic complexity, institutions, and income inequality”, *World Development*, 93, 75—93.

Khan, M., & Blankenburg, S. (2009). “The political economy of industrial policy in Asia and Latin America”, In G. Dosi, M. Cimoli, and J. E. Stiglitz (Eds.), *Industrial Policy and Development: The political economy of capabilities accumulation* (pp. 336-377). Oxford, UK: Oxford University Press.

Kohler, K. and Stockhammer, E. (2022) “Growing differently? Financial cycles, austerity, and competitiveness in growth models since the Global Financial Crisis”, *Review of International Political Economy*, 29:4, 1314-1341, DOI: 10.1080/09692290.2021.1899035

Lee, K. (2013), *Schumpeterian Analysis of Economic Catch-Up*, Cambridge University Press, Cambridge.

Lundvall B. (2007), “National Innovation Systems: Analytical Concept and Development Tool”, *Industry and Innovation,* 14 (1), pp. 95-119.

Oreiro J. L., Stefan Wilson D'Amato, Luciano Luiz Manarin D'Agostini, Paulo Sérgio De Oliveira Simões Gala (2022), “Measuring the technological backwardness of middle- and low-income countries: the employment quality gap and its relationship with the per capita income gap”, *PSL Quarterly Review*, vol. 75, Nº 301, junio.

Paula L.F., Fritz B. and Prates, D.M. (2017). “Keynes at the periphery: Currency hierarchy and challenges for economic policy in emerging economies”, *Journal of PostKeynesian Economics*, vol. 40, no 2, p. 183-202.

Ribeiro, R., McCombie, J. and Lima, G. T. 2017. ¨A reconciliation proposal of demand driven growth models in open economies¨, *Journal of Economic Studies*, vol. 44, no. 2, 226–44.

Samaniego, J. L., Sánchez, J. y Alatorre, J. E. (2022), «Medio ambiente y desarrollo en un contexto centro-periferia», El Trimestre Económico, vol. 89, No. 353, 5 de enero.

Spinola, D. (2020). “Uneven development and the balance of payments constrained model: terms of trade, economic cycles, and productivity catching-up. Structural Change and Economic Dynamics” , 54, 220–232.

Storm, S. and C. W. M. Naastepad (2012), *Macroeconomics beyond the NAIRU*, Cambridge, Harvard University Press.