Real exchange rate and economic complexity in a North-South structuralist BoPG model

LUCIANO FERREIRA GABRIEL, FABRÍCIO JOSÉ MISSIO*

Abstract:

The main objective of this work is to analyze theoretically and empirically the interrelationships between the real exchange rate (RER) and the economic complexity level in a Keynesian-Structuralist framework for two regions, the (developed) North and the (developing) South. In the analysis presented here, the RER level matters for influencing the industrial (manufacturing) share of GDP as well as the GDP growth rate compatible with the balance-of-payments equilibrium. Higher levels of economic complexity influence the South growth rate, depending on the effects of innovation, knowledge stock, and human capital on international trade. The empirical evidence in panel data suggests that undervalued RER and a higher manufacturing share in the developing-countries sample exhibit positive and significant effects on the economic complexity level.

A growing literature has shown evidence indicating that undervalued real exchange rate (RER) levels are positively associated with higher *per capita* growth rates. This evidence is robust to different estimation techniques, such as cross section ordinary least squares (OLS), fixed and random effects panel data, dynamic panel data (GMM), non-linear panel estimations and cointegration analysis.

Rodrik (2008) as well as Razmi et al. (2012), among others, verified significant differences between developed and developing countries, even when the threshold of GDP *per capita* is different in the definition of the developing countries' samples. Such differences are similar to those in other works, such as Dollar (1992), Gala (2008), Razin and Collins (1997).

Other studies have tested whether these results are robust to measurement errors. For instance, Vieira and MacDonald (2012) constructed seven different RER misalignment

---

measures. Even so, they found a significant and positive association between RER (undervalued) and economic growth.

According to Frankel and Rapetti (2014, p. 5) the causality runs from RER level to economic growth, although there might be room for debate, as highlighted by the authors. A rather important question concerning this relationship is about the mechanisms explaining how the undervalued RER level would affect economic growth. The strongest mechanism is one that rests on the important role played by modern tradable activities in the process of economic development. In other words, economic development consists of structural change, investment in new activities, and the acquisition of new productive capabilities (Rodrik, 2008).

These productive capabilities and knowledge cannot be easily acquired by workers or entrepreneurs. According to Hausmann et al. (2011), this kind of knowledge also requires structural change, i.e., developing a new industry requires changes in the pattern of interactions inside organizations and economic sectors. Moreover, the speed at which each country conducts structural transformation is a key factor that differentiates the income expansions and productivity gains (McMillan et al., 2014).

According to the Kaldorian and Structuralist approach, manufacturing represents the most important tradable sector, though some sophisticated services (e.g., finance services, software engineering, and so on) and knowledge-intensive agricultural activities (such as seed production) also play important roles in the structural change process. Given these features, the reallocation of resources to the modern tradable activities can accelerate economic growth.[1] In other words, the labor transferring from low productivity activities to high-productivity activities is an important driver of economic development (McMillan et al., 2014). The main hypothesis concerning this role played by manufacturing toward a more sophisticated economy can be tested through the analysis of how each sector, in aggregated terms, impacts economic complexity in the framework developed by Hausmann et al. (2011), as we do in this work.

In the Balance of Payment Constrained Growth (BoPG) models, the demand side of the economy is a factor of extreme importance to the process of industrialization and structural change. In this approach, asymmetric productive structures give rise to economic growth alongside an external constraint, as in Thirlwall (1979), McCombie and Thirlwall (1994), and Botta (2009), among others. Furthermore, the productive specialization in mature or stagnant technology sectors may reduce the competitiveness of these countries' goods, reinforcing the existing external constraint and the country's capacity to expand demand, diminishing the potential for economic growth. Thus, different productive structures generate differentiated growth trajectories.

In such a framework, long-run growth is demand constrained and the level of RER is neutral on growth dynamics because only continuous depreciation could foster it. However, there is robust evidence that undervalued RER is an important determinant of tradable profitability and capital accumulation (Frankel and Rapetti, 2014; Dao et al., 2017). Therefore, the level of RER influences the long-run supply of the domestic tradable sectors.

According to McMillan et al. (2014, pp. 26-27) the great difference between Asian and both Latin American and African productivity performance is accounted for by differences in the pattern of structural change. Since 1990, structural change in Latin America, in particular, has been growth-reducing, with the labor force transferring to less productive activities, notably

---

[1] Within an endogenous growth model, Rodrik (2008) demonstrates that the reallocations of resources in non-tradable activities can slower economic growth.

in services and the informal sector. In large part this process occurred because countries in Latin America, most notably Brazil and Argentina, have liberalized their economies with overvalued RER in a context of disinflationary monetary policies or short-term foreign capital inflows.

In light of the above-mentioned literature, the objective of this work is twofold. First, we present a Keynesian-structuralist North-South model of economic growth, where RER (level), industry (manufacturing) and economic complexity play important roles in the catching-up process in a BoPG framework. Second, we conduct empirical tests to analyze the main interrelationships presented in the model: if manufacturing plays an important role in the growth of economic complexity of different countries' samples and how RER impacts different economic sectors.

The novelty of this work is to present more clearly (with a formal model) the interrelationships between RER level, economic complexity and economic growth in a BoPG framework. In order to do so, we include in the analysis two new features: (*i*) the endogeneity of the industry-share growth rate (in terms of value added) in the South as a function of RER level, and (*ii*) the growth rates of exports and imports from the South (in terms of quantum), as a function of the level of economic complexity (*G*). In this case, we propose a formal definition of *G*. Furthermore, in empirical terms this work adds new evidence that highlights the importance of the RER and manufacturing on economic complexity.

To fulfill the proposed objectives, this paper is divided into four other sections. Section 1 presents a deeper discussion about economic growth, RER and economic complexity, to show that countries that achieve faster growth are those that are able to diversify away from agriculture and economic activities based on natural resources. Section 2 presents a Keynesian-Structuralist North-South simple model of economic growth, RER and economic complexity. Section 3 presents panel data estimations about the main interrelationships highlighted in the model. Finally, section 4 presents concluding remarks.

1. RER, economic growth, and economic complexity

One of the most central insights on economic growth is that this process implies structural change. The conventional literature highlights that the structural change can occur as a result of Engel's Law (Engel, [1857] 1895; and Houthakker, 1957), by the productivity growth trend (e.g., Baumol, 1967), or by some combination of the transformation into the production system (and labor) of the different sectors (Duarte e Restuccia, 2010).[2]

According to Bresser-Pereira (2014), for classical economists the productivity growth would stem from the change from low- to higher-skilled activities, through technological sophistication. In the same sense, when labor and other resources transfer from less productive to more productive activities, the economy grows at higher rates. Therefore, high-

---

[2] A broad view of the development process, dating back to Kuznets (1973), includes the commercialization of domestic production and the introduction of modern technologies in the household. According to this author: "The rate of structural transformation of the economy is high. Major aspects of structural change include the shift away from agriculture to non-agriculture pursuits, and, recently, away from industry to services; a change of the scale of productive units, and a related shift from personal enterprise to impersonal organization of economic firms, with a corresponding change in the occupational status of labor." (Kuznets, 1973, p. 248.) For a general overview about the theoretical and empirical literature on structural change, see Matsuyama (2008) and Herrendorf et al. (2013).

growth countries are typically those that have been able to experience growth-enhancing structural change (McMillan et al., 2014, p. 11).

To Kaldor (1967) and Rodrik (2006), there are special features in the industrial sector that make it a source of dynamism and an engine of long-term growth, mainly in developing countries. As this sector develops, externalities among firms and the productive sectors, along with their macroeconomic and distributive effects, may produce sudden leaps in the growth process or may block it (Rosenstein-Rodan, 1943). In doing so, it can generate successive phases of imbalance, given the capacity of industrial activities to be important vectors of the dynamism spreading in the economy, through its high backward and forward linkages (Hirschman, 1958). As highlighted by Ocampo (2005), these approaches imply, in short, that the dynamics of production structures are an active determinant of economic growth.

In this context, if the dynamics of the production structures matter to growth, then the question arises as to what are the variables capable of promoting structural change toward modern tradable activities. In this work we show that the RER level is an important variable in this process. That is, following the argument of the classical development economists (Nurkse, Myrdal, Rosestein-Rodan, Hirschman, Prebisch and Furtado), a change in the productive structure regarding the industrial sector is desirable in developing economies, given the inherent characteristics of this sector in increasing returns to scale, high synergies, and linkage effects. The point to be emphasized is that we include the RER as a variable capable of inducing industrial development and the associated technical progress.

This approach does not align with the canonical Thirlwall model (and its further developments), which maintained a certain skepticism about the importance of the exchange rate in economic development;[3] however, it is close to the approach of two more recent developments within post-Keynesian tradition, namely: (*i*) theoretical developments and empirical findings that show the importance of the RER on structural change and growth, and (*ii*) Developmental Macroeconomics, which places the RER at the center of the theory of economic development (Bresser Pereira, 2012).

Regarding this last point, according to Bresser-Pereira (2012, p. 8):

> Usually this macroeconomic price is not considered part of the development theory because it is presumed either that it floats gently around the current equilibrium, as in neoclassical theory, or that it floats in a volatile manner around this equilibrium, as in Keynesian theory. It would therefore be a short-term problem to be studied by macroeconomics. However, if instead of that we assume that the exchange rate tends to appreciate cyclically, it's easy to understand why it remains chronically overvalued, and therefore it is an issue of medium term also to be studied by development economics. An overvalued exchange rate prevents modern and efficient companies in developing countries have access to the international market.

In line with the literature analyzed, in the next section we develop a formal structure that is compatible with the following arguments:[4]

i. Economic development requires productive diversification;
ii. Developing countries with higher growth rates are those with the most significant industrial sectors (especially in manufacturing);

---

[3] This skepticism was due to the belief in the inability of an undervalued RER to produce changes in production or industrialization (Díaz-Alejandro, 1963; Krugman and Taylor, 1978; Arida and Bacha, 1984; and Fajnzylber, 1988).
[4] These arguments can be found to a large extent in Hausmann et al. (2008) for arguments i) and iv), in ECLAC (1990), Frenkel (2008), and Dao et al. (2017) for arguments v), vi) and vii), and in McMillan et al. (2014) for arguments ii) and iii).

iii. The growth acceleration is associated with structural changes towards the modern tradable sector;
iv. The productive diversification is not associated with well-endowed countries with natural resources and primary products.
v. The maintenance of a competitive RER favors the development of the tradable sector and thereby increases the average productivity of the economy (the production of these goods generates positive dynamic externalities throughout the economy);
vi. Undervalued RER stimulates investment in the modern export-oriented tradable sector because it increases the profitability of the firms;
vii. A stable and competitive RER stimulates the technological progress (first, because much of this progress is a consequence of capital accumulation, since new technologies are usually incorporated into new machines and equipment; second, because, by guaranteeing the profitability of the tradable sectors, the capacity for financing innovative activities of the firms is improved).

In a broad sense, there are many channels through which RER can affect economic growth. According to Rodrik (2008) the tradable sector is largely affected by market and institutional failures, which negatively impacts productivity. Furthermore, the misallocation of resources towards non-tradable leads to slower economic growth, mainly in developing countries.

In order to boost economic growth, an undervalued RER can be a second-best policy that compensates for these failures and improves the tradable sector profitability. Guzman et al. (2017) show that a stable and competitive RER policy may correct market failures (such as a suboptimal amount of investment in sectors characterized by learning spillover). Moreover, it makes investment in the tradable sector more profitable. Furthermore, transitory RER overvaluation can lead to (*i*) de-industrialization, which may hamper economic growth, and (*ii*) external crises with long-lasting negative impacts on growth (Skott et al., 2012).

Another possible channel in which RER affects economic growth relates to its influence on capital accumulation. RER undervaluation can increase the saving rate, which, in turn, translates into faster capital accumulation (Montiel and Severn, 2009). On the other hand, Levy-Yeyati and Sturzenegger (2009) relate the saving effects to distributional changes in the economy. In this case, undervalued RER tranfers income from workers to firms because it reduces real wages; as a result, capital accumulation is boosted.

According to Skott et al. (2012) the other strand of the accumulation channel linking RER to economic growth focuses on the balance of payments (BP). Developing countries can suffer from a lack of foreign currency. An undervalued RER changes the quantity of goods (and sectors) exported and imported. Concerning exports, the undervalued RER stimulates export-oriented investments because it facilitates access to external markets by firms and improves their profitability. On the contrary, overvalued currencies have strong profit-squeezing effects in the tradable sector, which usually bring investment rates down and increase imports (Gala, 2008).

In terms of technological progress, an undervalued RER can increase firms' capabilities regarding their innovative activities, such as Research and Development (R&D) as well as stimulate new investments in the modern tradable sector (especially, in manufacturing).[5] In doing so, a country's productive diversity grows. Conversely, natural resource products such

---

[5] Variable cash flow and sales, lagged one period, are the main determinants of investment in R&D (Hall, 1992; Himmelberg and Petersen, 1994; Harhoff, 1998). These variables are directly affected by RER.

as niobium, uranium or diamonds are more dependent on international demand and new markets (among other factors) but not on RER levels.

The increase of firms' capabilities related to their innovative activities and productive knowledge promotes diversification and sophistication of goods produced. Hausmann et al. (2011) developed a measure of economic complexity whereby diversity and ubiquity are approximations of the variety of capabilities available in an economy. While more diversified and less ubiquitous products tend to demand large quantities of capability and knowledge, such as aircraft, more ubiquitous products (e.g., cloths) or less ubiquitous products based on scarcity, such as niobium (and other natural resources), reflect the need for less capability and knowledge.[6] Insofar as RER affects the modern tradable sector, it follows that it can promote or damage the economic complexity of a country. This hypothesis is modeled in section 2 and empirically tested in section 3.

2. A Keynesian-Structuralist North-South model of economic growth, RER and economic complexity: a simple model

The starting point of the present model is the work of Botta (2009), which represents a benchmarking in the structuralist macroeconomics approach. Botta (2009) puts into evidence important post-Keynesian and evolutionary elements, in addition to addressing how structural change and different industry shares in the GDP affect uneven economic development between North (developed) and South (developing). However, in its original model the effects of the RER and economic complexity are not taken into account. Thus, our aim here is to make advances in these two aspects, mainly.

Following the structuralist approach and the demand-driven economic growth view, North-South productive asymmetries harm the economic growth of developing countries through their BP constraints on growth. Moreover, the emphasis on domestic industrialization as the key factor for North-South convergence is in accordance with Kaldorian and neostructuralist literature, which emphasizes the fundamental role of industry as an activity of increasing returns to scale and dynamic economies.[7] The latter refers to the increasing incomes brought about by technological progress induced by learning (specifically learning by doing) and by economies of scale.

A productive regime and a pricing dynamic are defined for the North and the South. In relation to the first, we have:

$$q_{nt} = r + \alpha_n g_{nt-1} \tag{1}$$

$$q_{st} = r + \alpha_s g_{st-1} \tag{2}$$

According to equations (1) and (2), the labor productivity growth rate q_{st} (South) and q_{nt} (North) depend on endogenous and exogenous components. The exogenous component is represented by r and is equal across countries, for the sake of simplicity. The endogenous

---

[6] Of course, low ubiquity can come from the need for large capability and knowledge. In this case, the products are more complex, such as X-ray machines and computerized tomography machines (CAT scan).

[7] It is not our goal here to discuss ECLAC contributions as a whole but, to a large extent for neostructuralism, industry is especially important as the sector with the greatest potential for content and dissemination of technical progress. Bielschowsky (2009) discuss in more depth the structuralist stage (1950s, 1960s, 1970s and 1980s) and the neo-structuralist phase (since 1990). He then reviews the most important contributions made between 1998 and 2008.

component α is a parameter that positively depends on the growth rate of the industry share in the economy g_{t-1} (in terms of value added). This component generates the Kaldor-Verdoorn cumulative effect.[8]

It is assumed that a constant mark-up rate, prices and monetary wages for the North and the South are defined as:

$$p_{nt} = w_{nt} - q_{nt} \tag{3}$$

$$w_{nt} = r + \rho_n \alpha_n g_{nt-1} \tag{3a}$$

$$p_{st} = w_{st} - q_{st} \tag{4}$$

$$w_{st} = r + \rho_s \alpha_s g_{st-1} \tag{4b}$$

The prices are defined by the difference between the monetary wage inflation (w) and the labor productivity growth rate (q). Moreover, according to structuralist theory, monetary wage inflation is an institutional variable, depending on the bargaining power of workers and the government's income distribution policies.

Following Botta's (2009) model, we assume that the exogenous component of labor productivity growth (r) is totally transferred to wages, both in the North and in the South. The endogenous component of the labor productivity growth rate affects wages by means of the parameters ρ, where $\rho_n \leq 1$ and $\rho_s \leq 1$.

In dynamic terms, the BP constraint, without capital flows, is:

$$p_{st} + x_{st} = p_{nt} + m_{st} \tag{5}$$

For all $t = 1, \dots, \infty$, with:

$$x_{st} = \beta_n(p_{nt} - p_{st}) + \varepsilon_n y_{nt} + \beta_{cx}(G) \tag{6}$$

$$m_{st} = \beta_s(p_{st} - p_{nt}) + \varepsilon_s y_{st} - \beta_{cm}(G) \tag{7}$$

In equations (6) and (7), x_{st} and m_{st} represent the growth rates of exports and imports, respectively, from the South (in terms of quantum). The variables y_{st} (for the South) and y_{nt} (for the North) represent the growth rates of income, β_s represents the price elasticity of imports from the South and β_n the price elasticity of exports from the North (both negative), and ε_s and ε_n are the income elasticities of imports and exports, respectively, from the South (both positive). Finally, G represents the variable of economic complexity, and β_{cx} and β_{cm} (both positive) represent the elasticities of the growth rate of exports and imports, respectively, in relation to the changes in the level of economic complexity from the South.

Following recent literature, the specifications of equations (6) and (7) take into account the relationship between technological competitiveness and trade (Verspagen, 1993; Léon-Ledesma, 2002; Romero and McCombie, 2018, among others). In this case, we are using general export and import functions in order to correctly specify in the model the possibility of supply-constraint on growth.

---

[8] Traditionally, according to Botta (2009), the economic literature about the effects of Kaldor-Verdoorn uses the growth rate of the aggregate output or the rate of growth of the industrial output. The so-called Verdoorn Law relates positively to the growth of production in manufacturing and the increase of productivity. Originally, this relationship appeared in the work of Petrus Johannes Verdoorn of 1949, entitled "Fattori che regolano lo sviluppo della produttività del lavoro". However, Nicholas Kaldor in 1966 discussed it as a "law", a qualification also known as a second law of Kaldor. Kaldor's first law identifies the industry as the engine of economic growth. Kaldor's third law reports that there is a strong positive correlation between industrial output growth and industry-led services and productivity growth outside industry.

In a broad sense, innovation, technological training and learning as well as the productive knowledge available in the economy, which is embedded in G (as explained below), are key factors affecting the South's non-price competitiveness. Moreover, in this work the income elasticity of demand reflects the product composition of exports and import in equations (6) and (7), respectively.[9] In this setting they are important to determine if the South's current account is either in equilibrium ($\varepsilon_n = \varepsilon_s$), in deficit ($\varepsilon_n < \varepsilon_s$), or showing a surplus ($\varepsilon_n > \varepsilon_s$). Furthermore, G represents a supply-side measure of relative technological competitiveness and of productive capacity between the North and the South.

The greater y_{nt} will positively influence ε_n magnitude. In turn, the greater y_{st} will positively influence ε_s magnitude. As North (South) income grows, more products will be demanded from the South (North). If the South's non-price competitiveness improves, it affects positively its export growth rates and negatively its import growth rates. Given the South's product features influenced by G, the export product composition is reflected in ε_n and the import product composition is reflected in ε_s. That is, in this model, G indirectly affects the trade elasticities.

According to Romero and McCombie (2018, p. 3), the demand function for different goods should take into account features of the products and their competitors, prices, and income of the consumers, among other variables. Notwithstanding, in macroeconomic research this is a very difficult task. Romero and McCombie (ibidem) explain that:

> [...] Traditionally, the Kaldorian literature considers that non-price factors are captured in the relative value of the income elasticity of demand, assuming that goods with higher demand have higher quality, given relative prices. This specification, therefore, is a second-best option, adopted in face of unobservable differences in quality (among other non-price competitiveness factors).

Therefore, the specifications in equations (6) and (7) allow G to capture how non-price competitiveness influences the South's trade performance in aggregative terms.[10] As G rises, that is, if the South's non-price competitiveness improves, it affects positively the export growth rate and negatively the import growth rate. In terms of exports, it is expected that greater economic complexity allows the country to produce goods of a higher quality, which result in a better performance in international trade. In term of imports, it is expected that greater economic complexity makes the South able to produce a greater diversity of products domestically, which implies that part of the external demand can also be attended by domestic production as well as imports.

In this setting, G captures differences in non-price competitiveness in order to provide more information on the determinants of export and import demand; thus, a part of the factors associated with non-price competitiveness is removed from income elasticities. Following Leon-Ledesma (2002), the form of specification of equations (6) and (7) presents non-price competitiveness as a factor that is not directly linked to income elasticity. However, this theoretical model includes the possibility that economic complexity indirectly affects income elasticities (ε_s and ε_n).[11]

---

[9] In this sense we are following Léon-Ledesma (2002). For a further discussion about the export and import functions we recommend Romero and McCombie (2018).

[10] In order to make this point even clearer: the higher demand of products (from any country), given greater national income, does not necessarily mean, that any product exhibits better quality, durability, and design, although, traditionally, there are models like that in the Kaldorian tradition.

[11] As discussed: $\frac{\partial \varepsilon_s}{\partial G} < 0$ and $\frac{\partial \varepsilon_n}{\partial G} > 0$. That is, we include the possibility of G affecting the international trade elasticities through its influence on export and import quantities.

Hausmann et al. (2011, p. 18, emphasis added) define the complexity of an economy as the multiplicity of useful knowledge embedded in the economic system:

> For a complex society to exist, and to sustain itself, *people who know about design, marketing, finance, technology, human resource management, operations and trade law must be able to interact and combine their knowledge to make products.* These same products cannot be made in societies that are missing parts of this capability set. *Economic complexity, therefore, is expressed in the composition of a country's productive output and reflects the structures that emerge to hold and combine knowledge.*

From this definition, G (economic complexity) follows the function:

$$G = \kappa(I_s - I_n) + \psi(H_s - H_n) + \zeta(T_s - T_n) \tag{8}$$

In equation (8), the level of economic complexity (G) depends on the innovative activities (I), the level of human capital (H) and the stock of knowledge (T), all in terms of their difference between the North (developed) and the South (developing). The parameters κ, ψ and ζ capture the elasticity of the innovative activities, human capital and the stock of knowledge, respectively, in relation to the level of economic complexity of the economy. Equation (8) expresses the capabilities of the South's economy in aggregate terms as cross-sector and economy-wide factors that influence economic complexity and international trade.

Innovative activities (I) are all those carried out internally by the firms that involve R&D. In this way, there is no incorporation of any possible absorption of technological spillovers from the North.

The concept of human capital used in equation (8) is related to the neoschumpeterian (or evolutionary) perspective, which relates the educational formation of the workers, as well as the training of the workforce, as proxies for technological training and learning-potential capability, which can affect growth through increased productivity and, later, by the Kaldor-Verdoorn mechanisms, the economic growth compatible with the constraint in BP.[12]

The stock of knowledge in equation (8) refers to the productive knowledge available in the economy already used by existing companies. It is easier for countries to produce new goods or provide new services from the knowledge they already have as long as this means adding little or no new productive knowledge. This process depends on the social accumulation of productive knowledge (Hausmann et al., 2011).

Substituting equations (1) to (4b), (6) and (7) into equation (5), we obtain the growth rate for the South consistent with the BP constraint:

$$y_{st} = \frac{(\beta_s + \beta_n - 1)[(w_{nt} - w_{st}) + \alpha_s g_{st-1} - \alpha_n g_{nt-1}]}{\varepsilon_s} + \frac{\varepsilon_n}{\varepsilon_s} y_{nt} + \frac{(\beta_{cx} + \beta_{cm})[\kappa(I_s - I_n) + \psi(H_s - H_n) + \zeta(T_s - T_n)]}{\varepsilon_s} \tag{9}$$

Equation (9) implies that the growth rate consistent with BP equilibrium depends on the growth rate of the North, on the elasticities ratio of exports and imports, on the price competitiveness expressed by the difference between the wage growth rates and the productivity differentials growth rate associated with the share of manufacturing in the economy, that is, the effect of the Kaldor-Verdoorn Law, and on non-price competitiveness. In equation (9) we consider $\beta_s + \beta_n > 1$, in the way that Marshall-Lerner's condition is valid.

---

[12] This definition of human capital used is also well synthesized by Hall (1992, p. 170), where: "[...] the term human capital is used broadly here to include not just the skills generated by formal education and training, but those created by on-the-job training and experience of technological activity, and the legacy of inherited skills, attitudes and abilities that aid industrial development".

Regarding non-price competitiveness, it can be observed that, for the South, the growth rate of human capital, the stock of knowledge and innovation, *per se*, does not increase the South's rate of economic growth compatible with BP equilibrium. This occurs because they depend on interaction with elasticities of the growth rate of exports and imports in relation to changes in the level of economic complexity for the South ($\beta_{cx} + \beta_{cm}$). Formally:[13]

$$\frac{\partial y_{st}}{\partial G} = \frac{(\beta_{cx}+\beta_{cm})\varepsilon_s+\varepsilon_n'\varepsilon_s.y_{nt}-\varepsilon_s'N}{\varepsilon_s^2} > 0 \tag{9a}$$

By means of equation (9a), we can observe that the economic growth rate compatible with BP equilibrium depends on how the relevant amount of knowledge of the economy influences the South's international trade.[14]

As G influences positively the South's exports toward goods with greater non-price competitiveness, there is a trend to reduce the South's import income elasticity (ε_s) over time; meanwhile, there is a trend for the South's export income elasticity (ε_n) to rise. This occurs through indirect effects (not modeled) of G over export and import composition (which are reflected on the income international trade elasticities). As explained, income elasticity of demand reflects the product composition of exports and import.

In this sense, we are following Thirlwall (2005, p. 52), where exports differ from other components of demand in three important respects. First, exports are the only true component of autonomous demand in an economic system.[15] Second, exports are the only component of demand that can pay for the import requirements for growth. According to Thirlwall (ibidem) the growth process may be led by consumption, investment or government expenditure for a short time because each of these components of demand has import content. So, exports are of great significance if BP equilibrium on current account is a long-run requirement. This means that exports have not only a direct effect on demand, but also an indirect effect by allowing all other components of demand to rise faster than otherwise would be the case. The third important aspect of exports is that imports (permitted by exports) may be, in the short run, more productive than domestic resources because certain crucial goods necessary for development are not produced in the South. In this model this ability to produce more productive goods in the South depends, crucially, on G and g_{st}.

The change (e) in RER follows the function:

$$e = \phi(\theta_r^* - \theta_r) \tag{10}$$

In this formulation we are following Ferrari et al. (2013). In equation (10) θ_r^* represents the real exchange rate target (determined by monetary policymakers) and θ_r represents the RER compatible with BP equilibrium. In a simplified way, θ_r is one in which there are no changes in foreign exchange reserves and is at a level compatible with stability of domestic

---

[13] In equation (9a), the term N is equal to $(\beta_s + \beta_n - 1)[(w_{nt} - w_{st}) + \alpha_s g_{st-1} - \alpha_n g_{nt-1}] + \varepsilon_n y_{nt}+(\beta_{cx} + \beta_{cm})G$. Furthermore, $N>0$ because we are assuming that Marshall-Lerner's condition holds, the monetary wage inflation in the South is smaller than in the North (otherwise, this would mean RER overvaluation) and $g_{st-1}>g_{nt-1}$, as $\theta_r^* > \theta_r$ (explained below). The remaining parameters are discussed after equation (9a). It is worth mentioning that we are not considering the extreme case of continuous recession or crises in the North, where y_{nt} could be negative.

[14] It must be noted that ε_s' and ε_n' are first-order derivative, i.e., the import income elasticity rate of growth and the export income elasticity rate of growth, respectively, from the South.

[15] The major part of consumption and investment demand is dependent on the growth of income itself (Thirlwall, 2005).

prices. Furthermore, ϕ measures the rate of adjustment of RER to the target (θ_r^*). It is a parameter under control of the monetary authorities.[16]

The growth rate of the industry share (in terms of value added) in the South is influenced by a function of RER level as defined in equation (11), such that:

$$g_{st} = -\alpha_2 + \alpha_3\theta_r^* - \alpha_4(\theta_r^*)^2 \tag{11}$$

In Equation (11), $\alpha_i > 0$ (for i=2, 3 and 4). This equation represents the growth rate of the industry share in the South as a nonlinear function of θ_r^*. This equation behavior is shown in figure 1.

Figure 1 – *Industry share growth rate and RER level (θ_r^*)*
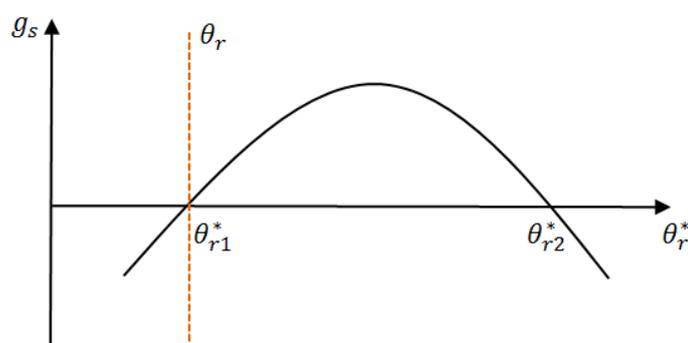
As we have just seen, competitive RERs can foster economic growth in this model through their influence on industry. Notwithstanding, RER excessive devaluations or overshootings have negative impacts on the industry share growth rate and y_{st}.[17] Then, the θ_r^* choice by the policymaker is not arbitrary. In figure 1, θ_r^* must lie between θ_{r1}^* and θ_{r2}^*. Otherwise, the RER level has a negative impact on g_{st}.[18]

The idea underlying equation (11) is that firms in the South operating below the technological frontier and, therefore, at a disadvantage from the point of view of non-price competitiveness, can compensate for this disadvantage with some competitive price advantage, which is represented here by a real exchange rate greater than θ_r (and between θ_{r1}^* and θ_{r2}^*). In other words, an undervalued RER can improve industrial profitability, fostering its

---

[16] As seen before, in this model the monetary wage inflation is an institutional variable, depending on the bargaining power of workers and the government's income distribution policies. A way of influencing RER is through this channel, i.e., by policymakers influencing the pace of monetary wage inflation (w_{st}). The lesser the monetary wage inflation, the more undervalued is RER, because it decreases South price levels (p_{st}). In the short run, this can be compensated by income distribution policies. In the long run, the acceleration of the labor productivity growth rate resulting from the structural change could compensate the initial wage losses. Another way of keeping a stable and competitive RER is by using controls on capital inflows. However, it is not our goal here to examine this last issue. For that, we recommend Frankel and Rapetti (2014).

[17] In the event of excessive undervaluation, this may lead to an increase in the production costs, especially in the industrial segments that operate with a great amount of imported inputs. Thus, the profitability of these activities decreases, influencing negatively its share in the industrial sector. In this case $\theta_r^* > \theta_{r2}^*$ in figure 1.

[18] It is worth to mention that g_{st} reaches a maximum at $\theta_r^* = \frac{\alpha_3}{2\alpha_4}$. Moreover, θ_r^* has increasing impact on g_{st} when is at $\theta_{r1}^* < \theta_r^* < \frac{\alpha_3}{2\alpha_4}$. Conversely, θ_r^* has a decreasing impact on g_{st} when is at $\frac{\alpha_3}{2\alpha_4} < \theta_r^* < \theta_{r2}^*$. With this formulation, stability is ensured in this model when $\theta_r^* = \theta_{r1}^*$ or $\theta_r^* = \theta_{r2}^*$. In other words, the monetary policymakers do not decide the level of θ_r^* greater than θ_r in a permanent way.

growth in terms of value added. Conversely, excessive overvaluation can reduce the tradable industries share in the South's economy, mainly because it damages the firms that operate at tight profit margins.[19]

In this way, the dynamic of the growth rate of the industry share in the South's economy has effects on the income growth rate of this region. By means of equation (9) we can observe that the greater g_{st}, the greater y_{st}, through its effects on α_s.

According to Tregenna (2009) the growth-pulling properties of manufacturing operate mainly through value added share and output. First, the manufacturing effects through backward and forward linkages with the rest of an economy are more related to manufacturing share in GDP and growth of manufacturing output than its share of employment or growth in manufacturing employment. This occurs because, if this sector is growing, then it can give rise to higher demand for inputs from backward-linked sectors as well as provide stimulus and potentially lower input costs to forward-linked sectors.

Second, as learning-by-doing applies not only at the level of individual workers but also in terms of management and the planning of production and technology, manufacturing output is also relevant. This learning-by-doing process is one channel of the manufacturing productivity endogeneity growth to manufacturing output growth. Moreover, it is the output of manufacturing (both in level and its share) that is more relevant to its net BP position (Tregenna, 2009, p. 440).

Although in the modern tradable sector there are many knowledge-intensive services (or sophisticated services), Guerrieri and Meliciani (2005) have found that the development of an internationally competitive service sector depends on manufacturing. In particular, they found that knowledge-intensive industries (e.g., chemical and pharmaceutical industries, computer equipment, communication equipment, among others) are the main users of financial services, communication and business services (various kind of services provided to companies).

To a large extent, this result is also corroborated by Marconi (2015). In spite of the growth of services in the productive structure of several countries, there is evidence that the smaller share of manufacturing industries generates lower growth in the modern service sector, to the detriment of the growth of services with lower *per capita* value added, productivity and related technological content. This process results in less productive sophistication and, in turn, lowers rates of economic growth.[20] More importantly, from the point of view of structural change, RER (level) is one important determinant of industrial tradable profitability and, therefore, the capital accumulation of this sector (Frenkel and Rapetti, 2014).

In this model, the industry (specifically manufacturing) is an important source of economic complexity, in other words, directly influencing *G.* This occurs because manufacturing offers greater opportunities for the progress of incorporated technologies in goods, increasing the use of capabilities by the firms and the learning-by-doing processes. Furthermore, this sector has a greater capacity for technological diffusion to other sectors and, therefore, presents better features for knowledge diffusion. Part of this dynamic occurs because of the so-called productive linkages and spillover effects, which are stronger in this sector.

---

[19] In this case, $\theta_r^* < \theta_{r1}^*$ in figure 1. In section 3, Rodrik's (2008) undervaluation measure is used to test its influence on manufacturing and economic complexity.

[20] According to Marconi (2015, p. 31), "productive sophistication" occurs when there is an increase in the production share in sectors with higher value added per worker. These sectors demand more qualified workers, that is, with a higher level of human capital, increasing the potential of value added in the goods and productivity.

In order to simplify the analysis of equation (9), let us assume that in the long run wage inflations from the North and the South regions are the same and the growth rates of the manufacturing industries in relation to the two regions are not different. By so doing, the South economy no longer relies on manufacturing as an engine of growth, this role can be fulfilled by other sectors, such as services. In this way, equation (9) becomes:

$$y_{st} = \frac{\varepsilon_n}{\varepsilon_s} y_{nt} + \frac{(\beta_{cx} + \beta_{cm})G}{\varepsilon_s} \tag{12}$$

According to equation (12), convergence for the South depends on the ratio magnitudes concerning income international trade elasticities and on the ratio between elasticities of the growth rate of exports and imports in relation to changes in the level of economic complexity for the South $(\beta_{cx} + \beta_{cm})G$ and income elasticities of imports. The greater these ratios, the faster the convergence.

3. Productive structure, RER, and economic complexity: panel data estimations

As discussed in sections 1 and 2, manufacturing industries represent the most important tradable sector, mainly to developing countries. Given these features, the reallocation of resources to modern tradable activities can accelerate economic growth. Different sectors are influenced by RER in very different manners. If manufacturing is affected in a negative way, economic growth can be hampered, as the North-South model demonstrated in section 2 (equations 9 and 11). In the same way, economic complexity can be reduced or its rate of growth slowed, hampering sustainable economic growth and the increase of exports with more knowledge-based content for the South, which are very important for BP equilibrium (equations 6, 7 and 9) and convergence (analyzed from equation 12).[21]

In this section, we test how the different sectors (in aggregated terms) of 118 economies respond to a measure of RER (table A1 presents the sample of countries). The sectors are divided by the *International Standard Industrial Classification* (ISIC) (see table 1). The variable *misxrate* is calculated from three steps (Rodrik, 2008). First, the nominal exchange rates from the countries ($XRAT_{it}$) and the conversion factor of purchasing power parity (PPP_{it}) are used to calculate the real exchange rate (RER_{it}):

$$lnRER_{it} = ln(XRAT_{it}/PPP_{it}) \tag{13}$$

where the index *i* represents the 118 countries in the sample and *t* the time index, which in this work is 22 years (1990-2011). The variables $XRAT_{it}$ and PPP_{it} are expressed in terms of dollars. RER values above one indicate that the national currency is more undervalued than indicated by the purchasing power parity (PPP_{it}). However, the non-tradable sector is also cheaper in poorer countries (through the Balassa-Samuelson effect), which requires an adjustment. Thus, the second step takes into account this effect, regressing RER_{it} in relation to *per capita* GDP:

$$lnRER_{it} = \alpha + \beta ln(GDPpc_{it}) + f_t + u_{it} \tag{14}$$

where f_t is the fixed effect for the period of time and u_{it} is the idiosyncratic error term.

---

[21] The econometric exercise in this section is based on the model, although not strictly related to the entire formal structure developed.

Finally, the following equation calculates Rodrik's (2008) $misxrate_{it}$ indicator:

$$ln(misxrate_{it}) = lnRER_{it} - ln\widehat{RER}_{it} \tag{15}$$

Defined this way, the variable $misxrate_{it}$ is comparable between the panels of countries over time. When $misxrate_{it}$ is above unity, the RER is set so that domestically produced goods are relatively cheaper in terms of the dollar, that is, RER is undervalued. Conversely, when $misxrate_{it}$ is below unity, RER is overvalued.

Table 1 briefly describes all the variables used in the estimations.

Table 1 – *Description of the variables used in the model, its measures and sources*

Abbreviation	Brief variable description	Source
GDPpc	*Per capita* GDP in real terms (US dollars – 2005).	IMF
GDPpcgr	Real *per capita* GDP growth rate	IMF
vamanu	Manufacturing sector share to GDP (value added, in %) – 15-37 divisions from the *International Standard Industrial Classification* (ISIC)*	WDI – GGDC
vaprim	Primary sector share to GDP (value added, in %) – 1-5 division from *International Standard Industrial Classification* (ISIC)*	WDI – GGDC
vaserv	Services sector share to GDP (value added, in %) – 50-99 divisions from *International Standard Industrial Classification* (ISIC)*	WDI – GGDC
gaptec	Technological gap between countries from Verspargen (1993) methodology	Based on PWT 8.0
misxrate	RER adjusted by the Balassa-Samuelson effect according to Rodrik (2008) – undervaluation measure	Based on PWT 8.0
ppp	Purchasing Power Parity (PPP) in relation to GDP of each country measured in 2005 US dollars	PWT 8.0
xrat	Nominal exchange rate for each country in terms of US dollars	PWT 8.0
rer	RER adjusted by Purchasing Power Parity (PPP)	Based on PWT 8.0
ainfla	Annual inflation rate (from the *Consumer Price Index* – CPI, for each country)	WDI
ainv	Gross fixed capital formation as a proportion of annual GDP	WDI
govexp	Government consumption in terms of goods and services in relation to GDP in real terms	World Bank
ttrade	Terms of trade: index calculated as the percentage ratio of the unit export value index in relation to the unit import value index – base year 2000	WDI
eci	Hausmann et al. (2011) complexity indicator	MIT

Notes: * Revision 3.0 of the *International Standard Industrial Classification* for economic activities of the United Nations Statistics Division (UNSD); Value added is the net product of the economic sector after adding the gross value of the entire product and subtracting the intermediate goods involved in the production process. It was calculated without taking into account deductions for depreciation, depletion and degradation of natural resources. Relative participation (%) calculated at constant prices in terms of 2005 dollars. IMF: International Monetary Fund; WDI: *World Development Indicators*; PWT: *Penn World Tables* 8.0 (see Feenstra et al., 2015); MIT: Massachusetts Institute of Technology; and GGDC: Groningen Growth and Development Center.

The following panel data econometric models are tested:

$$\text{vamanu}_{it} = \beta_0 + \beta_1 \text{misxrate}_{it} + \beta_2 \text{gaptec}_{it} + \beta_3 \sum_{J=4}^{K} \beta_j Z_{i,tj} + \mu_t + \eta_i + u_{it} \tag{16}$$

$$\text{vaprim}_{it} = \beta_0 + \beta_1 \text{misxrate}_{it} + \beta_2 \text{gaptec}_{it} + \beta_3 \sum_{J=4}^{K} \beta_j Z_{i,tj} + \mu_t + \eta_i + u_{it} \tag{17}$$

$$\text{vaserv}_{it} = \beta_0 + \beta_1 \text{misxrate}_{it} + \beta_2 \text{gaptec}_{it} + \beta_3 \sum_{J=4}^{K} \beta_j Z_{i,tj} + \mu_t + \eta_i + u_{it} \tag{18}$$

$$\text{eci}_{it} = \beta_0 + \beta_1 \text{misxrate}_{it} + \beta_2 \text{gaptec}_{it} + \beta_3 \text{vaprim}_{it} + \beta_4 \text{vamanu}_{it} + \beta_5 \text{vaserv}_{it} + \beta_6 \sum_{J=4}^{K} \beta_j Z_{i,tj} + \mu_t + \eta_i + u_{it} \tag{19}$$

where the variable $vamanu_{it}$ represents the share of the manufacturing industries in terms of its value added in GDP, $vaprim_{it}$ represents the share of the primary sector in terms of its value added in each country, $vaserv_{it}$ represents the share of the service sector in terms of its value added in each country, and eci_{it} is the variable of economic complexity, calculated by Hausmann et al. (2011). The variable $misxrate_{it}$ is the undervaluation index taking into account the Balassa-Samuelson effect, $gaptec_{it}$ represents the technological gap, and $Z_{i,tj}$ are the K control variables to each country i, over time t. The β_j's are the parameters to be estimated, μ_t is the time specific effect, η_i captures the non-observed effects of each country i that are invariant over time, and u_{it} is the idiosyncratic error term.

The control variables used to estimate equations (16)-(19) follow the literature on economic growth and structural change (Bhalla, 2012, Szirmai and Verspagen, 2011, Rodrik, 2008, among others) and can be classified according to the following variables: (*i*) government liabilities: the share of government expenditure in *per capita* GDP (*govexp*) is used as a proxy; (*ii*) stabilization policies: the average inflation rate (*ainfla*); (*iii*) the technological gap (*gaptec*) is defined following the methodology used by Verspagen (1993), among others. In this case the technological leader is the United States and its *per capita* GDP is a proxy for productivity; (*iv*) gross fixed capital formation as a proportion of annual GDP (*ainv*) as a proxy for aggregated investment; (*v*) the population growth rate (*pop*), which affects negatively the average *per capita* income and thus the countries' rate of growth, and (*vi*) terms of trade (*ttrade*), which negatively affect economic growth when RER is overvalued.

A higher technological gap, a larger government consumption share, or high population growth rates tend to make countries grow more slowly. Likewise, economies with high inflation rates tend to grow more slowly than those with more stable prices. Conversely, economies with high levels of investments tend to have higher economic growth rates. Moreover, a worsening of the terms of trade tends to devalue RER, which can boost economic growth.

The first model estimated is from equation (16). In order to choose between fixed and random effects, we used the Hausman (1978) test. The results show that the null hypothesis of the non-systematic coefficients is rejected for both samples, indicating the fixed effects model. We used the modified Wald test for heteroskedasticity in regression models with fixed effects and the Wooldridge test for serial correlation in the panel model. The results indicate that the errors of the model are serially correlated and heteroskedastic, both results with 1% statistical significance. Moreover, the Collin test (Ender, 2015) was applied and the problem of multicollinearity was not detected (the VIF, i.e., the variance inflation factor average was as low as 1,10).

In this context, we used the Generalized Least Squares (GLS) method, which corrects for heteroskedasticity and autocorrelation. For the latter, the autoregressive component of

idiosyncratic error term is modeled as a "within" AR(1) process and the heteroskedasticity was modeled for each panel.

The results are presented in table 2. It can be observed that the undervalued RER positively affects manufacturing industries with statistical significance in all samples, but with higher magnitude in the emerging or developing economies when compared to the broad and advanced economies. Moreover, a high technological gap has a negative sign but is not statistically significant for the advanced economies and it is positive but not statistically significant for the sample of emerging economies. The control variable *ainv* obtained the positive and significant sign for the broad sample of advanced economies and a positive but not statistically significant sign for the emerging economies. The *ainfla* variable was positive and significant for all three estimations. The *pop* control variable presents a negative and statistically significant sign, except for advanced economies. Finally, *govexp* presents a negative sign in the broad sample and in the advanced economies sample, but it was statistically significant only for the latter.

Table 2 – *Panel GLS (Generalized Least-Squares) estimations for advanced or developed countries and emerging or developing countries, 1990-2011*

$VAMANU_{it}$	Broad sample	Advanced countries	Emerging or developing economies
misxrate	1.286***	0.704*	1.510***
	(7.38)	(2.54)	(7.60)
gaptec	0.00199	−0.345	0.00143
	(0.37)	(−0.84)	(0.27)
ainfla	0.00260***	0.0261***	0.00207***
	(4.30)	(6.67)	(3.32)
ainv	0.0170***	0.0758***	0.00854
	(3.37)	(3.78)	(1.62)
pop	−0.381***	−0.125	−0.469***
	(−5.52)	(−0.84)	(−6.93)
govexp	−0.0140	−0.204***	0.00282
	(−1.21)	(−5.56)	(0.23)
β_0	16.01***	20.77***	15.69***
	(59.29)	(21.15)	(58.22)
N	2112	380	1732

Note: *t* statistics in parenthesis. * p<0.05, ** p<0.01, *** p<0.001.

In order to estimate (17) the Hausman test indicates that the most appropriate model has fixed effects (with 1% significance). Again, we used the modified Wald test for heteroskedasticity for fixed effects models and the Wooldridge test for serial correlation in the panel model estimated. The results indicate that the model error term is serially correlated and

heteroskedastic, both results with 1% significance. Moreover, the Collin test (Ender, 2015) was applied and the problem of multicollinearity was not detected (the VIF average was as low as 1,18).

To correct the detected problems, we used the GLS method, which corrects for heteroskedasticity and autocorrelation. For the latter, the autoregressive component of idiosyncratic error term is modeled as a "within" AR(1) process and the heteroskedasticity was modeled for each panel.

It can be observed in table 3 that the undervalued RER has a negative and statistically significant effect on the primary sector of the sample for the emerging countries and a positive and statistically significant sign for the advanced economies. In other words, this evidence suggests that it is the exchange appreciation that positively affects the primary sector for developing economies. The technological gap variable is not significant for the primary sector in all the estimated panels. The control variable *ainv* is negative and significant for the broad sample and for the emerging economies and is positive and statistically significant for the advanced economies. The *pop* variable is positive and statistically significant for the broad sample and for the emerging economies but negative and not statistically significant for the advanced economies, while the variable *govexp* is negative and statistically significant for the broad sample and the emerging economies but not for the sample of advanced economies.

Table 3 – *Panel GLS (Generalized Least-Squares) estimations for advanced or developed countries and emerging or developing countries, 1990-2011*

$VAPRIM_{it}$	Broad sample	Advanced countries	Emerging or developing economies
misxrate	−0.408	0.939***	−0.863**
	(−1.81)	(5.04)	(−2.80)
gaptec	−0.0163	0.494	−0.0188
	(−1.08)	(1.96)	(−1.26)
ainfla	0.00108***	0.0234***	0.00106***
	(4.24)	(7.24)	(4.44)
ainv	−0.0722***	0.0475***	−0.0793***
	(−8.36)	(3.89)	(−8.71)
pop	1.226***	−0.286**	1.142***
	(9.82)	(−2.64)	(7.81)
govexp	−0.229***	0.0251	−0.153***
	(−10.09)	(1.25)	(−6.34)
β_0	19.82***	1.273*	23.47***
	(35.66)	(2.20)	(39.60)
N	2184	398	1786

Note: *t* statistics in parenthesis. * p<0.05, ** p<0.01, *** p<0.001.

In order to estimate equation (18), the Hausman test indicates that the most appropriate model has fixed effects (with 1% significance). Once again, we used the modified Wald test for heteroskedasticity in regression models with fixed effects and the Wooldridge test for serial correlation in the panel model. The results indicate that the errors of the model are serially correlated and heteroskedastic, both results with 1% significance. Moreover, the Collin test (Ender, 2015) was applied and the problem of multicollinearity was not detected (the VIF average was as low as 1,12).

Once more, to correct the detected problems, we used the GLS method, which corrects for heteroskedasticity and autocorrelation. In the latter, the autoregressive component of idiosyncratic error term is modeled as a "within" AR(1) process and the heteroskedasticity was modeled for each panel.

It can be observed in table 4 that the undervalued RER has no statistically significant affect on the service sector in all panels estimated. Furthermore, the technological gap variable is not statistically significant for the service sector in all the estimated panels. Only the control variable *govexp* is statistically significant in all estimations, but with a positive sign. The variable *ainv* is negative and statistically significant for the emerging or developing economies and positive and statistically significant for the advanced countries' sample. The variable *pop* presents a negative sign and is statistically significant only for the sample of advanced countries.

Table 4 – *Panel GLS (Generalized Least-Squares) estimations for advanced or developed countries and emerging or developing countries, 1990-2011*

$VASERV_{it}$	Broad sample	Advanced countries	Emerging or developing economies
misxrate	−0.192	−0.387	−0.772
	(−0.77)	(−1.18)	(−1.96)
gaptec	0.0199	0.0188	0.997
	(1.61)	(1.52)	(1.69)
ainfla	−0.000329	−0.000287	−0.0375***
	(−1.31)	(−1.21)	(−6.54)
ainv	0.0430***	0.0492***	−0.127***
	(5.14)	(5.47)	(−4.18)
pop	−0.995***	−0.754***	0.0154
	(−8.32)	(−5.57)	(0.07)
govexp	0.521***	0.415***	0.486***
	(19.39)	(13.98)	(7.06)
β_0	46.26***	44.77***	60.73***
	(76.56)	(69.24)	(32.76)
N	2184	398	1786

Note: *t* statistics in parenthesis. * p<0.05, ** p<0.01, *** p<0.001.

The manufacturing industries, according to the Kaldorian and Structuralist approach, are of great importance for the convergence of the South toward a greater economic rate of growth, as discussed in section 1. Industry plays a key role as an activity of increasing returns to scale and dynamic economies. The latter refers to the increasing returns brought about by technological progress induced by learning (specifically learning-by-doing) and by economies of scale. Controlling for other variables, the empirical evidence found suggests that the undervalued RER affects manufacturing in a positive way for the sample of developing or emerging countries. Except for the variable *ainfla*, all of the other control variables in table 2 that affect economic growth also influence manufacturing industries, as the expected sign described in the beginning of this section.

Model (19) was estimated for a reduced sample (see table A2) because the economic complexity variable (*eci*) was not available for the broad sample (see table A1). This reduced sample is divided among developed countries (20 countries) and emerging or developing economies (68 countries). The estimations to these different samples faced the same problems concerning heteroskedasticity and serial autocorrelation, when we applied the modified Wald test for heteroskedasticity in regression models with fixed effects and the Wooldridge test for serial correlation in the panel model, respectively. Thus, in order to correct the detected problems, we used the GLS method.

To check the robustness of the results, we applied the Cochrane-Orcutt method with the Prais-Winsten transformation to correct for problems of serial correlation and heteroskedasticity. As Cameron and Trivedi (2005) present, the Prais–Winsten transformation removes the heteroskedasticity and autocorrelation, and the results are unbiased coefficients and consistent panel corrected standard errors. Furthermore, when calculating the standard errors and the variance-covariance matrix, it is assumed that the errors are heteroskedastic and contemporaneously correlated between panels. This was done for the complete estimation (table 5, seventh column).

The results for emerging or developing economies of equation (19) are reported in table 5. Except for the proxy to stabilization policies, all of the control variables presented the expected sign and are statistically significant in the most complete model estimated (sixth column). For all estimations the undervalued RER has a positive impact on economic complexity. Moreover, manufacturing is the main sector in terms of its impact on *eci.* The results for the PCSE (Panel Corrected Standard Errors) estimation are not different in terms of the sectorial impacts on (*eci*), but they are different in terms of the control variable results: *gaptec* (positive and not statistically significant)*, ainfla* (positive and statistically significant), and *ttrade* (negative and not statistically significant).

Table 5 – *GLS (Generalized Least-Squares) panel estimations and PCSE (Panel Corrected Standard Errors) estimations – emerging or developing economies, 1990-2011*

ECI_{it}	(1)	(2)	(3)	(4)	(5)	(6)	(7)
misxrate	0.0246	0.0497	0.0790**	0.111***	0.109***	0.0668*	0.106**
	(1.05)	(1.73)	(2.82)	(4.29)	(3.90)	(2.05)	(2.75)
vaprim		−0.0185***	−0.0204***	−0.0156***	0.00768***	−0.00540*	−0.0186***
		(−13.06)	(−15.87)	(−9.12)	(−3.38)	(−2.03)	(−6.37)
vamanu			0.0135***	0.0204***	0.0195***	0.0237***	0.0285***
			(5.55)	(8.17)	(7.95)	(8.95)	(10.20)
vaserv				0.00925***	0.0118***	0.0159***	0.0160***
				(5.17)	(6.60)	(7.95)	(10.13)
gaptec					−0.00410***	−0.00354***	0.000586
					(−6.78)	(−5.55)	(1.21)
ainv					0.00251*	0.00529***	0.0139***
					(2.07)	(4.09)	(4.34)
pop						−0.0626***	−0.0862***
						(−4.91)	(−6.31)
ainfla						0.0000810	0.000403**
						(1.26)	(2.66)
ttrade						−0.000614**	−0.000600
						(−2.73)	(−1.48)
β_0	−0.465***	−0.0640	−0.313***	−0.921***	−1.045***	−1.253***	−1.451***
	(−15.68)	(−1.83)	(−6.15)	(−7.06)	(−7.74)	(−7.56)	(−7.14)
N	1419	1413	1344	1340	1303	1130	1130

Note: *t* statistics in parenthesis. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

The results for developed-country estimations of equation (19) are reported in table 6. Contrary to the results for emerging or developing countries, the proxy for stabilization policies, aggregated investment and terms of trade are not statistically significant. However, *gaptec* and *pop* have the expected sign and are statistically significant. Although this is true, for all estimations the undervalued RER has a negative impact on economic complexity for this sample of countries and manufacturing presents the strongest impact on economic complexity. This result corroborates the hypothesis presented in the model developed in the last section, that manufacturing industries positively influence complexity in the economies, in this case even for the developed countries.

Table 6 – *GLS (Generalized Least-Squares) panel estimations and PCSE (Panel Corrected Standard Errors) estimations – developed economies, 1990-2011*

ECI_{it}	(1)	(2)	(3)	(4)	(5)	(6)	(7)
misxrate	–0.158**	–0.142*	–0.238***	–0.235***	–0.153*	–0.0869	–0.0180
	(–3.01)	(–2.33)	(–3.53)	(–3.57)	(–2.42)	(–1.12)	(–0.18)
vaprim		–0.0778***	–0.119***	–0.0909***	–0.0187	–0.140***	–0.203***
		(–5.67)	(–8.36)	(–5.75)	(–1.12)	(–7.55)	(–12.01)
vamanu			0.0636***	0.0613***	0.0589***	0.0738***	0.0916***
			(10.41)	(8.88)	(9.24)	(9.96)	(17.09)
vaserv				0.00999	0.0184***	0.0221***	0.0246***
				(1.74)	(3.30)	(3.36)	(5.12)
gaptec					–0.141***	–0.126***	–0.0894***
					(–7.38)	(–4.38)	(–3.93)
ainv					–0.00101	0.00140	–0.00857
					(–0.29)	(0.31)	(–1.29)
pop						–0.127**	–0.150**
						(–2.74)	(–2.81)
ainfla						0.000137	–0.0156
						(0.02)	(–1.25)
ttrade						0.000842	–0.00120
						(0.44)	(–0.46)
β_0	1.693***	1.786***	0.642***	–0.0331	–0.463	–0.929	–0.871
	(31.76)	(30.33)	(4.99)	(–0.07)	(–0.95)	(–1.37)	(–1.37)
N	427	407	389	389	389	234	234

Note: *t* statistics in parenthesis. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

In order to control for individual unobserved characteristics of the sample that affect the dependent variable and the possible endogeneity of independent variables, we use dynamic panel (GMM) methodology in equation (19) for developing and developed countries (table 7).[22] Thereby, we applied the system GMM by Arellano and Bover (1995) and Blundell and Bond (1998). This method creates a system of regressions in difference and in level. The instruments of the regressions in the first difference remain the same as in the GMM difference. The instruments used in the regressions in level are the lagged differences of the explanatory variables.

---

[22] Endogeneity implies correlation between the covariates and the error term, that is, $E(X_{it}u_{it}) \neq 0$. In the dynamic model it takes into account eci lagged effects on the present, so the conventional method (OLS) to panel data leads to inconsistent estimates, since this variable is correlated with the error term c_i. Moreover, the traditional sources of endogeneity are due to dynamic effects such as cited, simultaneity between variables, omitted variables or measurement errors of variables (Greene, 2012).

Table 7 – *Dynamic panel-data estimation, two-step system GMM (robust), 1990-2011*

ECI_{it}	Developing countries	Developed countries
l.eci	0.787***	0.919***
	(25.28)	(30.21)
misxrate	−0.212*	−0.174
	(2.03)	(−1.88)
l.misxrate	0.389*	0.123
	(2.03)	(1.50)
vaprim	−0.00399*	−0.0244**
	(−2.13)	(−2.81)
vamanu	0.00654**	0.00966***
	(3.10)	(3.97)
vaserv	0.00307*	0.00254**
	(2.06)	(2.74)
gaptec	0.00000402	−0.0180*
	(0.01)	(2.05)
ainv	0.00206	0.000448
	(1.36)	(0.17)
pop	−0.0142	0.000849
	(−1.12)	(0.04)
ainfla	0.0000589	−0.00852*
	(1.90)	(−2.29)
ttrade	−0.000222	0.000719
	(−0.51)	(1.85)
β_0	−0.272	−0.284***
	(−1.92)	(−3.59)
Arellano and Bond's test for AR(1) – *A*	z = −3.89 Pr > z = 0.000	z = −3.47 Pr > z = 0.001
Arellano and Bond's test for AR(2) – *A*	z = −0.52 Pr > z = 0.600	z = 0.92 Pr > z = 0.357
Hansen test of joint validity of instruments (p–value) – *B*	chi2(39) = 42.24 Prob > chi2 = 0.333	chi2(37) = 41.20 Prob > chi2 = 0.292

Note: Two-step standard errors are robust to heteroskedasticity (Windmeijer, 2005). The *t* (*s*) statistics are in parenthesis; * p<0.05, ** p<0.01, *** p<0.001. In *A* – The null hypothesis: there is no "n" order correlation in the residues. In *B* – The null hypothesis: the model is correctly specified and all over-identifications are correct.

In table (7) the undervalued RER has a positive impact on economic complexity for the emerging or developing countries. However, this result is not contemporaneous. On the other hand, lagged or contemporaneous effects of *misxrate* are not statistically significant for the developed countries. Although, with a different econometric technique, manufacturing industries positively influence complexity in the economies, even for the developed countries. This positive effect is greater than what is observed for the service sector. Concerning the control variables, just *gaptec* and *ainfla* present the expected sign and are statistically significant for the sample of developed countries.

In all estimations reported in table 7, we do not reject the null hypothesis that over-identified restrictions are valid at the 1% level of significance. Similarly, we do not reject the null hypothesis that there is no autocorrelation for higher order. Furthermore, with the two-step estimations, efficient and robust parameters for any standard of heteroskedasticity were obtained, whereas, for Windmeijer's (2005) standard errors, the downward bias for the standard errors in the estimators was avoided.

4. Concluding remarks

In terms of the theoretical model developed in this work, the dynamic of the industry growth rate in the South's economy has positive effects on its income growth rate. When it is assumed that the wage structures of the North and the South regions are the same and that the growth rates of the manufacturing industries in relation to the two regions are not different, convergence for the South depends on the ratio magnitudes concerning international trade income elasticities and on the ratio between the elasticities of the growth rate of exports and imports in relation to the changes in the level of economic complexity for the South and the income elasticities of imports.

Controlling for other variables, the empirical evidence in this work suggests that the undervalued RER affects manufacturing in a positive way in the sample of developing or emerging countries. This means that an overvalued RER can hamper economic growth in developing economies through its influence on manufacturing industries. In other words, the panel data estimations show that an excessively overvalued RER can accelerate structural heterogeneity, affecting the industrial sector in a particularly negative way. This process implies a regressive productive specialization, mainly in developing economies that hampers economic growth and complexity.

According to the Kaldorian and Structuralist approach, manufacturing industries are of great importance for economic growth. Manufacturing industries play a key role as an activity of increasing returns to scale and dynamic economies. Our empirical findings suggest that manufacturing also plays an important role on the countries' economic complexity. This occurs because, insofar as RER affects this modern tradable sector, it also affects the higher capacity of technological diffusion to other sectors. Part of this dynamic is a consequence of the productive linkages and spillover effects, which are stronger in manufacturing industries.

Economic diversification, proxied here by the economic complexity index, plays a central role in the long-term growth of emerging and developing countries. Thus, structural change toward activities in the modern tradable sector is one key determinant to a higher economic rate of growth.

Appendix

Table A1 – *Sample of countries for the estimations in tables 2, 3 and 4*

Developed countries	Developing countries
Australia, Austria, Denmark, Finland, France, Germany, Greece, Italy, Japan, Korea. Rep., Latvia, Lithuania, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, United States.	Antigua and Barbuda, Argentina, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo. Dem., Congo. Rep., Costa Rica, Cote d'Ivoire, Cyprus, Dominica, Dominican Republic, Ecuador, El Salvador, Estonia, Ethiopia, Fiji, Gabon, Georgia, Ghana, Grenada, Guinea, Guinea-Bissau, India, Indonesia, Iran. Islamic Rep., Jordan, Kenya, Lao PDR, Liberia, Macao SAR, China, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Niger, Nigeria, Oman, Pakistan, Panama, Paraguay, Philippines, Russian Federation, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, South Africa, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sudan, Suriname, Swaziland, Tajikistan, Tanzania, Thailand, Togo, Trinidad and Tobago, Turkey, Turkmenistan, Uganda, Ukraine, Uruguay, Uzbekistan, Venezuela RB, Vietnam, Zambia, Zimbabwe.
(N=20 and T=22)	(N=98 and T=22)

Table A2 – *Sample of countries for the estimations in tables 5 and 6*

Developed countries	Developing countries
Australia, Austria, Denmark, Finland, France, Germany, Greece, Italy, Japan, Korea. Rep., Latvia, Lithuania, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, United States	Argentina, Bangladesh, Bolivia, Botswana, Brazil, Bulgaria, Cameroon, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt. Arab Rep., El Salvador, Estonia, Ethiopia, Gabon, Georgia, Ghana, Guinea, India, Indonesia, Iran. Islamic Rep., Jordan, Kenya, Lao PDR, Liberia, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nigeria, Oman, Pakistan, Panama, Paraguay, Philippines, Russian Federation, Saudi Arabia, Senegal, Singapore, South Africa, Sudan, Tajikistan, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, Uruguay, Uzbekistan, Venezuela. RB, Vietnam, Zambia, Zimbabwe.
(N=20 and T=22)	(N=68 and T=22)

Source: based on the WDI's (2015) classification.

References

Arellano M. and Bover O. (1995), "Another Look at the Instrumental Variable Estimation of Error-Components Models", *Journal of Econometrics*, 68 (1), pp. 29–51.

Arida P. and Bacha E.L. (1987), "Balance of Payments: A Disequilibrium Analysis for Semi-Industrialized Economies", *Journal of Development Economics*, 27 (1-2), pp. 85-108.

Bhalla Surjit S. (2012) *Devaluing to prosperity: misaligned currencies and their growth consequences.* Peterson Institute for International Economics*. Washington,* DC, August.

Baumol W.J. (1967), "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis", *American Economic Review*, 57 (3), pp. 415–426.

Bielschowsky R. (2009), "Sixty Years of ECLAC: Structuralism and Neo-Structuralism", *Cepal Review*, 97 (April), pp. 171-192.

Blundell R. and Bond S. (1998), "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models", *Journal of Econometrics*, 87 (1), pp. 115-143.

Botta A. (2009), "A Structuralist North-South Model on Structural Change, Economic Growth and Catching-Up", *Structural Change and Economic Dynamics*, 20 (1), pp. 61-73.

Bresser-Pereira L.C. (2008), "The Dutch Disease and Its Neutralization: A Ricardian Approach", *Brazilian Journal of Political Economy*, 28 (1), pp. 47-71.

Bresser-Pereira L.C. (2012), "The exchange rate at the center of development economics", Estudos Avançados 26 (75), 2012.

Bresser-Pereira L.C., (2014), *A Construção Política do Brasil. Sociedade, economia e Estado desde a Independência*, São Paulo (Brazil): Editora 34.

Bresser-Pereira L.C., Oreiro J.L. and Marconi N. (2015), *Developmental Macroeconomics: New Developmentalism as a Growth Strategy*", London: Routledge.

Cameron A. and Trivedi P. (2005), *Microeconometrics: Methods and Applications*, Cambridge: Cambridge University Press.

Dao M.C., Minoiu C. and Ostry J.D. (2017), "Corporate Investment and the Real Exchange Rate", *IMF Working Paper Series*, no. 17/183, Washington (DC): International Monetary Fund.

Díaz-Alejandro C.F. (1963), "A Note on the Impact of Devaluation and the Redistributive Effect", *Journal of Political Economy*, 71 (6), pp. 577-580.

Dollar D. (1992): "Outward-Oriented Developing Economies Really Do Grow More Rapidly: Evidence from 95 LDCs, 1976-1985", *Economic Development and Cultural Change*, 40 (3), pp. 523-544.

Duarte M. and Restuccia D. (2010), "The Role of the Structural Transformation in Aggregate Productivity", *Quarterly Journal of Economics*, 125 (1), pp. 129-173.

ECLAC – Economic Commission for Latin America and the Caribbean (1990), *Changing Production Patterns with Social Equity: The Prime Task of Latin American and Caribbean Development in the 1990s*, (LC/G.1601-P), Santiago (Chile): United Nations Publication.

Ender Phillip B. (2015). Collin test. Available at: http://www.philender.com/courses/categorical/notes2/collin.html.

Engel E. ([1857] 1895), "Die Productions- und Consumptionsverhaeltnisse des Koenigsreichs Sachsen", *Zeitschrift des Statistischen Buereaus des Koeniglich Saechsischen Ministeriums des Inneren*, 8 and 9; as reprinted in the Appendix I of Engel E. (1895), "Die Lebenskosten Belgischer Arbeiter- Familien, früher und jetzt", *International Statistical Institute Bulletin*, 9, pp. 1-54.

Fajnzylber F. (1988): "Competitividad internacional: evolución y lecciones", *Revista de la CEPAL*, n. 36, pp. 7-24.

Feenstra, Robert C., Inklaar, Robert e Timmer, Marcel P. The Next Generation of the Penn World Table. *American Economic Review*, 105(10), 3150-3182. 2015.

Ferrari M.A.R., Freitas F.N.P. and Barbosa-Filho N.H. (2013), "A taxa de câmbio real e a restrição externa: uma proposta de releitura com elasticidades endógenas", *Revista de Economia Política*, 33 (130), pp. 60-81.

Frenkel R. (2008): "The competitive real exchange-rate regime, inflation and monetary policy". *CEPAL Review*, 96: 191-201.

Frenkel E. and Rapetti M. (2014), "The Real Exchange Rate as a Target of Macroeconomic Policy", MPRA Paper no. 59335, Munich (Germany): University Library of Munich, available at https://mpra.ub.uni-muenchen.de/59335/1/MPRA_paper_59335.pdf.

Greene W.H. (2012), *Econometric Analysis*, 7th ed., Upper Saddle River (NJ): Prentice Hall.

Gala P. (2008), "Real Exchange Rate Levels and Economic Development: Theoretical Analysis and Econometric Evidence", *Cambridge Journal of Economics*, 32 (2), pp. 273-288.

Guerrieri, P. and Meliciani, V. (2005) Technology and international competitiveness: The interdependence between manufacturing and producer services. *Structural Change and Economic Dynamics*. 16, 489–502.

Guzman M., Ocampo J. and Stiglitz J. (2017), "Real Exchange Rate Policies for Economic Development", *NBER Working Paper Series*, no. 23868 (September), Cambridge (MA): National Bureau of Economic Research.

Hall B.H. (1992), "Investment and Research and Development at the Firm Level: Does the Source of Financing Matter?", *NBER Working Paper Series*, no. 4096 (June), Cambridge (MA): National Bureau of Economic Research.

Harhoff D., (1998): "Are there financing constraints for innovation and investment in German manufacturing firms?" *Annales d'Économie et de Statistique,* 49/50, pp. 421-456.

Hausman J. A. (1978), "Specification Tests in Econometrics," *Econometrica*, 46, 1251–1271.

Hausmann R., Hidalgo C.A., Bustos S., Coscia M., Chung S., Jimenez J., Simoes A., Yildirim M.A. (2011), *The Atlas of Economic Complexity: Mapping Paths to Prosperity*, Hollis New: Puritan Press.

Herrendorf B., Rogerson R. and Valentinyi A. (2013), "Growth and Structural Transformation", *CEPR Discussion Papers*, no. DP9370, London: Centre for Economic Policy Research.

Himmelberg C.P. and Petersen B.C., (1994), "R&D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries", *Review of Economic and Statistics* 76 (1), pp. 38-51.

Hirschman A. (1958), *The Strategy of Economic Development*, New Haven (CT): Yale University.

Houthakker H.S. (1957), "An International Comparison of Household Patterns, Commemorating the Century of Engel's Law", *Econometrica*, 25 (4), pp. 532-551.

Kaldor N. (1966) *Causes of the slow rate of economic growth of the United Kingdom*, Cambridge: Cambridge University Press.

Kaldor N. (1967), "Problems of Industrialization in Underdeveloped Countries", in *Strategic Factors in Economic Development* (pp. 53-72), Ithaca (NY): Cornell University Press.

Krugman P. and Taylor L. (1978), "Contractionary Effects of Devaluation", *Journal of International Economics*, 8 (3), pp. 445-456.

Kuznets S. (1973), "Modern Economic Growth: Findings and Reflections", *American Economic Review*, 63 (3), pp. 247-258.

Léon-Ledesma M.A. (2002), "Accumulation, Innovation and Catching-Up: An Extended Cumulative Growth Model", *Cambridge Journal of Economics*, 26 (2), pp. 201-216.

Levy-Yeyati E. and Sturzenegger F. (2009), "Fear of Appreciation: Exchange Rate Policy as a Development Strategy", in Hammond G., Kanbur R. and Prasad E. (eds.), *Monetary Policy Frameworks for Emerging Markets* (pp. 69-94), Cheltenham (UK) and Northampton (MA): Edward Elgar Publishing.

Marconi N. (2015): "Estrutura produtiva e desenvolvimento econômico", in Barbosa N., Marconi N., Pinheiro M.C. and Carvalho L. (eds.), *Indústria e desenvolvimento produtivo no Brasil* (pp. 31-70), Rio de Janeiro: Elsevier, Fundação Getúlio Vargas.

McCombie, J. and Thirlwall, A. (1994). *Economic growth and the balance of payments constraint.* New York: St. Martin's Press, 1994.

Matsuyama K. (2008), "Structural Change." In Durlauf S. and Blume L. E. (eds.), *The New Palgrave Dictionary of Economics* (pp. 52-55), 2nd ed., London: Palgrave Macmillan.

McMillan M., Rodrik D. and Verduzco-Gallo Í. (2014), "Globalization, Structural Change, and Productivity Growth, with an Update on Africa", *World Development*, 63, pp. 11–32.

Montiel P. and Serven L. (2009), "Real Exchange Rates, Saving, and Growth: Is There a Link?", *Working Paper*, no. 46, Washington (DC): Commission on Growth and Development and World Bank.

Ocampo J. A. (2005): "The Quest for Dynamic Efficiency: Structural Dynamics and Economic Growth in Developing Countries", in Ocampo J.A. (ed.), *Beyond Reforms: Structural Dynamics and Macroeconomic Vulnerability* (pp. 3-43), Palo Alto (CA): Stanford University Press and Washington (DC): World Bank.

Prebisch R. (1964), *Nueva política comercial para el desarrollo*, México: Fondo de Cultura Económica.

Razin, O and Collins, S. (1997) Real Exchange Rate Misalignments and Growth. *International Finance 9707001*, EconWPA.

Razmi A., Rapetti M. and Skott P. (2012), "The Real Exchange Rate and Economic Development", *Structural Change and Economic Dynamics*, 23 (2), pp. 151-169.

Rodrik, D. (2006). Industrial development: stylized facts and policies. Draft prepared for the U.N.-DESA publication Industrial Development for the 21st Century. Available at: https://drodrik.scholar.harvard.edu /publications/industrial-development-stylized-facts-and-policies-revised.

Rodrik D. (2008): "Real Exchange Rate and Economic Growth", *Brookings Papers on Economic Activity,* Fall.

Romero J.P. and McCombie J.S.L. (2018): "Thirlwall's Law and the Specification of Export and Import Functions", *Metroeconomica*, 69 (2), pp. 366-395.

Rosenstein-Rodan, P.N. (1943) Problems of industrialization in Eastern Europe and South-Eastern Europe. *Economic Journal,* n.53.

Syrquin M. (1988), "Patterns of Structural Change", in Chenery H. and Srinivasan T.N. (eds.), *Handbook of Development Economics*, vol. 1 (pp. 203-273), Amsterdam: North Holland Elsevier.

Szirmai A. and Verspagen B. (2011), "Manufacturing and Economic Growth in Developing Countries, 1950-2005", *UNU-MERIT Working Papers*, no. 069, Maastricht: United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT).

Skott P., Rapetti M. and Razmi A. (2012), "Real Exchange Rates and the Long-Run Effects of Aggregate Demand in Economies with Underemployment", *Economics Department Working Paper Series*, no. 146, Amherst: University of Massachusetts Amherst, available at: https://scholarworks.umass.edu /econ_workingpaper/146.

Thirlwal, A.P. The balance of payments constraint as an explanation of international growth rates differences, *Banca Nazionale del Lavoro Quarterly Review*, v, 128, p, 45-53, 1979, In: *PSL Quartely Review*, vol, 64 n,259 (2011), 429-438.

Thirlwal, A.P. (2005) A A natureza do crescimento econômico: um referencial alternativo para compreender o desempenho das nações. Brasilia : lpea.

Tregenna F. (2009), "Characterising Deindustrialisation: An Analysis of Changes in Manufacturing Employment and Output Internationally", *Cambridge Journal of Economics*, 33 (3), pp. 433-466.

Verdoorn, P. (1949). Fattori che regolano lo sviluppo della produttivita del lavouro. L'Industria, 1, p. 3- 10.

Verspagen B. (1993), *Uneven Growth Between Interdependent Economies: An Evolutionary View on Technology Gaps, Trade and Growth*, Aldershot: Avebury.

Vieira, F. V.; MacDonald, Ronald. (2012) A Panel Data Investigation of Real Exchange Rate Misalignment and Growth. Estudos Econômicos (São Paulo. Impresso), v. 42, p. 433-456.

Windmeijer F. (2005), "A Finite Sample Correction for the Variance of Linear Efficient Two-Step GMM Estimators", *Journal of Econometrics*, 126 (1), pp. 25-51.