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Kaldor´s Paradox, Industrial Equilibrium Exchange Rate and Technological Gap: a reconciliation of New-Developmentalism with stylized facts

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Kaldor´s Paradox, Industrial Equilibrium Exchange Rate and Technological Gap: a reconciliation of New-Developmentalism with stylized facts♣

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Abstract: One of the main propositions of the new-developmentalist school is the idea the over-valued exchange rates – due to Dutch disease and the adoption of a growth model with foreign savings – hampers economic growth by reducing the manufacturing share in output, i.e., causing a process of deindustrialization and also provoking an unsustainable increase in the current account led by an increase in the manufacturing trade deficit that is not compensated by the increase in exports of primary goods due to their low income elasticity of demand (Bresser-Pereira, Oreiro and Marconi, 2015). The problem with this proposition is its incompatibility with the so-called Kaldor´s paradox, the empirical regularity discovered by Kaldor (1978) and confirmed by the subsequent empirical literature (Boggio and Barbiere, 2016) that a country manufacturing share in world´s manufacturing exports exhibits a negative correlation with the relative unit labour costs, which means that exchange rate devaluations that are able to reduce the relative real wages are associated with a decrease, rather than an increase, of a country manufacturing share in world´s manufacturing exports. The main objective of this article is to show that using the concept of industrial equilibrium exchange rate of Oreiro, Martins da Silva and Dávila-Fernandez (2020) article in a macro-Schumpeterian model developed by Fagerberg (2007) the Kaldor´s paradox can be explained as the result of an appreciation of industrial equilibrium exchange rate due to a reduction in the level of technological gap. In such a framework an overvaluation of exchange rate – relative to industrial equilibrium - continues to be harmful for economic growth, but appreciation of the industrial equilibrium exchange rate does not have such an effect.

Key-Words: Real Exchange Rate, Technological Gap, New-Developmentalism, Nicholas Kaldor.

JEL CODE: O11; O14; O3; O4.

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1. Introduction

New-Developmentalism understood as an approach to the deep determinants of economic development in which macroeconomic policy regime has a key-role in international growth rate differences, mainly amongst middle-income countries (Oreiro, Martins da Silva and Dávila-Fernandez, 2020, p. 26), always emphasizes the importance of a competitive real exchange rate for developing countries to catch-up with developed countries. Indeed, Bresser-Pereira (2012, p. 10), the founding father of new-developmentalism and structuralist development macroeconomics, stated that "structuralist macroeconomics places the exchange rate at the centre of the theory of economic development". This idea is fully developed by Bresser-Pereira, Oreiro and Marconi (2015) textbook where a Keynesian-Structuralist model is built where exchange rate overvaluation due to Dutch-Disease and Foreign Savings Growth Model based on the so-called Washington Consensus results in premature deindustrialization and hence in a reduction of the ratio of income elasticities of exports and imports, thereby reducing growth rate compatible with balance of payments constraint and also the warranted growth rate due to the reduction in investment rate caused by the profit squeeze induced by real exchange rate over-valuation. The macroeconomic result is a long-term reduction in economic growth, increasing unemployment as well as income inequality due to the reduction in the growth rate of real wages.

It is important to notice that for new-developmentalism more important than the level of real exchange rate is the difference between the actual level of real exchange rate and the so-called industrial equilibrium level, defined as the long-term equilibrium level for real exchange rate in which domestic firms that operates with state-of-art technology are capable to compete with foreign firms both on domestic and international markets (Bresser-Pereira, Oreiro and Marconi, 2015, p.59). As stated by Oreiro and Martins da Silva and Dávila-Fernandez (2020), the problem with this definition of industrial equilibrium exchange rate is that most companies in middle-income countries do not operate with technology in the state of the world art, but behind the technological frontier, which means that firms in the middle-income countries face a noticeable *technological* *gap*, a concept developed by Fagerberg (1988a)[1]. According to Fagerberg, the *technological gap* is the difference in technological capabilities between countries, which creates a potential for economic growth through imitation by less advanced countries. This gap is reduced by the diffusion of technology, but countries must invest in their own social capabilities and infrastructure to successfully *catch up*. The theory sees technological progress as an ongoing process driven by innovation in leading countries and imitation in follower countries, where economic growth is a result of successfully bridging the gap.

The full incorporation of the technological gap within the definition of industrial equilibrium exchange rate was done by Oreiro, Martins da Silva and Dávila-Fernandez (2020) according to whom industrial equilibrium exchange rate is defined as the level of real exchange rate for which, given the technological gap, is capable to maintain the share of manufacturing industry in output constant in the long-term. This level of real exchange rate is an equilibrium level because is compatible with a constant production structure through time. For a country that wants to increase the manufacturing share to some predetermined target (x% of GDP) then the required macroeconomic policy is to target the real exchange rate at a level slightly above the industrial equilibrium level for the period necessary to achieve the target. Targeting real exchange rate will demand a macroeconomic police regime that combine a flexible and autonomous monetary policy with some kind of capital and exchange rate controls as well as export taxes over primary commodities and foreign reserve accumulation. This macroeconomic regime is not compatible with inflation targeting, where policy interest rates are determined to achieve the target inflation rather than to target real exchange rate. Inflation control must be done by income policies in combination with a fiscal policy designed to manage aggregate demand to avoid inflationary pressures.

One important aspect of this definition of industrial equilibrium exchange rate is that it is no longer an exogenous variable defined in some ad-hoc way, but it is a linear and positive

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[1] In conversation with Bresser-Pereira regarding the problem of supposing that firms of middle-income countries use state-of-art technology, Bresser replied to me that he does not want to build a theory that is based on productive inefficiencies of domestic firms to justify a competitive exchange rate. Inefficiencies of private firms must be punished by *market mechanisms*, which means bankruptcy. I understand his reasoning, but I argued that even if a firm can make the best use of the technology that it is capable to access, this does not means that this technology is the state-of-art technology; because technology is not a free good and firms had to invest heavily in R&D for create new technologies or even imitating the new technologies developed by firms that operates in the technological frontier.

function of the technological gap. This means that a country that had an overvalued exchange rate can reduce this overvaluation also by adopting industrial and science and technology policies that aims to reduce the technological gap and, hence, the level of industrial equilibrium exchange rate. This allowed a reconciliation between New Developmentalism with both Latin-American Structuralism and Neo-Schumpeterian economics.

One major criticism against New-Developmentalism is the so-called *Kaldor Paradox*. Kaldor (1978) when evaluating the effect of exchange rate devaluation over manufacturing exports performance of a sample of developed countries, founds a positive correlation between the main industrial countries' relative manufacturing export shares with that of their relative unit costs (Boggio and Barbiere, 2016, p. 2). Since relative unit costs are closely related with relative prices, then what Kaldor found is that appreciation in real exchange rate is associated with an increase in the export share of manufacturing goods of the most successful countries in the sample which are Germany, Italy and Japan. This represents a clear change in Kaldor´s mind since in his 1971 article Kaldor wrote that "[T]he main autonomous factor governing both the level and the rate of growth of effective demand of an industrial country with a large share of exports in its total production and of imports in its consumption is the *external demand* for its exports: and the main factor governing the latter is *international competitiveness*, which in turn depends on the level of its industrial cost relatively to other industrial exporters" (Kaldor, 1971, p.7). But some years latter Kaldor wrote that "There is only one important matter on which the events of the 1970s caused me to change my mind. This concerns the relative importance of price (or cost?) competition, as against other "non price" factors, such as superiority of design or quality, length and reliability of delivery dates, after-sales service, etc. Exchange rate adjustments operate mainly on cost and prices, and despite vast changes in relative exchange rates—in real, and not just in nominal terms—there was little effect on the pattern of trade in manufacturing" (Kaldor, 1986, p.25).

Is it possible to reconciliate the role of real exchange rate in economic development as stated by New-Developmentalism with the empirical regularity of the Kaldor Paradox? Our answer to this question is yes. As noticed by Boggio and Barbieri (2016) "changes in export performance must be 'explained' by levels rather than by *changes* in unit costs". This opens a channel by which the level of industrial equilibrium exchange rate can affect the growth performance of a country besides the effect of real exchange rate overvaluation. In other words, exchange rate overvaluation could damage economic growth for *a given level of technological gap*; but if a country is reducing this gap than a decrease in the industrial equilibrium level of real exchange rate, i.e. an appreciation of equilibrium exchange rate, may not necessarily be negative for growth performance.

The main objective of this article is to propose a New-Developmentalist solution for the Kaldor´s Paradox using the modified concept of industrial equilibrium exchange rate developed by Oreiro, Martins da Silva and Dávila-Fernandez (2020) in a technological gap growth model developed by Fagerberg (2007). The inclusion of industrial equilibrium exchange rate within Fagerberg´s theoretical framework will allow us to conclude that an appreciation of equilibrium exchange rate through reducing technological gap is compatible with an increase in the growth performance of a country relative to the rest of the world; at the same time that an exchange rate overvaluation – that is an appreciation of actual real exchange rate relative to the industrial equilibrium exchange rate – will produce precisely the opposite effect.

This result had very powerful policy implications. Economic development requires both a wise macroeconomic policy as well as an intelligent industrial and science and technological policy. Macroeconomic policy must avoid exchange rate overvaluation for having a positive effect over the rate of economic growth. This is the core of *Developmental Macroeconomics*, the idea that is not possible or desirable to separate macroeconomics from economic development. But macroeconomic policy alone is not enough. Technology is not a free good and demands a lot of investment in Research and Development, which is subject to strong Keynesian uncertainty. Free markets will not, by themselves, solve the technological deficiencies of firms in technological backward countries. Investment in innovation and imitation cannot be relied upon the animal spirits of entrepreneurs. So, governments must have well designed policies for reducing the technological gap over time, with the result of producing a sustainable long-term appreciation in equilibrium real exchange rate. This is completely opposed to exchange rate populism that plagues Latin American countries from time to time.

The article is organized in four sections, including this introduction. The second section presents the original structure of the technological-gap growth model developed by Fagerberg (2007). The third section modified the model to introduce the concept of industrial equilibrium exchange rate. The fourth section presents the final remarks.

2. Fagerberg 2007 Technological Gap Growth Model

Let us consider a small open economy that produces an homogeneous good according to the following technology:

$$Y = A_1 Q^{\alpha} C^{\beta} \qquad (1)$$

Where: Y is GDP, Q is the level of technological knowledge, C is the capacity to explore the benefits from technological knowledge[2], $A_1 > 0, \alpha > 0 \; and \; \beta > 0$ are parameters.

Technological knowledge, in turn, is a function of knowledge diffusion from other countries (D) and the knowledge created in the region or country (N).

$$Q = A_2 D^{\gamma} N^{\lambda} \quad (2)$$

We will assume that the diffusion of technological knowledge by means of technological spillovers assume the form a logistic curve:

$$d = \phi_0 - \phi_1 \left[\frac{T}{T_*}\right] \quad (3)$$

Where: d is the growth rate of technological diffusion.

This implies that the contribution of diffusion of externally available knowledge to economic growth is an increasing function of the distance between the level of knowledge appropriated in the country and that of the country on the technological frontier (for the frontier country, this contribution will be zero by definition) [Fagerberg, 2007, p. 709). The total amount of knowledge, adjusted for differences in size of countries, in the frontier country and the country under consideration, are T* and T, respectively.

[2] The capacity to explore the benefits of technological knowledge depends on many factors. The first of all is the capital equipment per worker, which depends on the investment rate. The so-called human capital, defined, for instance, by the years of formal education of workers with more than 25 years old had (Ros, 2013, chapter 1), is also important for exploring the benefits of technological knowledge. Social capital can also important, since it comprises the networks of relationships which are productive towards advancing the goals of individuals and groups; although a recent study of Xue, Reed and Aert (2024), based on an analysis of 957 estimates from 83 studies, finds that find that social capital effects over economic growth can range from large negative to large positive, suggesting that its impact on economic growth varies substantially depending on the context.

It is important to notice that $\left[\frac{T}{T_*}\right]$ is the technological gap of the country relative to technological frontier. For a backward country we had $0 < \left[\frac{T}{T_*}\right] < 1$. For a country that operates in technological frontier we had $\left[\frac{T}{T_*}\right] = 1$

Taking logs and time derivative of equation (2), we get:

$$q = \gamma d + \lambda n \quad (4)$$

Where: q is the growth rate of technological knowledge and n is the growth rate of knowledge created within the country.

Substituting (3) into (4) we get:

$$q = \gamma\phi - \gamma\phi\left[\frac{T}{T_*}\right] + \lambda n \quad (4)$$

Equation (4) shows that the higher is the technological gap, i.e. lower is $\left[\frac{T}{T_*}\right]$, higher will be the growth rate of technological knowledge due to the higher technological spillovers from foreign countries. This is a simple formalization of the ideas developed by economic historian Gerschenkron (1962) whom, on the basis of his studies of European catch-up processes, suggested that the technological gap between a frontier and a latecomer country represented ‘a great promise’ for the latter, since it provided the latecomer with the opportunity of imitating more advanced technology in use elsewhere (Fagerberg, 2007, p. 707).

Taking logs and time derivative of equation (1), we get:

$$y = \alpha q + \beta c \quad (5)$$

Where: y is the growth rate of GDP and c is the growth rate of the capacity to explore the benefits of technological knowledge.

Substituting (4) into (5), we get:

$$y = \alpha\gamma\phi - \alpha\gamma\phi\left[\frac{T}{T_*}\right] + \alpha n + \beta c \quad (6)$$

Equation (6) shows the determinants of the growth rate of the home country. To determine the relative growth rate of home country (y_{rel}), we must deduce from (6) the equivalent expression for the rest of the world (w). So, we get:

$$y_{rel} = y - w = -\alpha\gamma\phi\left[\frac{T - T_w}{T}\right] + \alpha(n - n_w) + \beta(c - c_w) \quad (6)$$

Hence, according to equation (6), the rate of growth of a country may be seen as the outcome of three sets of factors: (a) the potential for exploiting knowledge developed elsewhere, $\left[\frac{T-T_w}{T}\right]$ (b) creation of new knowledge in the country (innovation), $(n - n_w)$ and (c) complementary factors affecting the ability to exploit the potential entailed by knowledge (independently of where it is created), $(c - c_w)$.

Fagerberg (1987, 1988a) applied this model to a sample of developed and medium income countries, and showed that all three factors, innovation, diffusion and complementary capabilities, mattered for growth. It was shown that countries that caught up very fast also had very rapid growth of innovative activity. The analysis presented in Fagerberg (1988a) suggested that superior growth in innovative activity was the prime factor behind the huge difference in performance between Asian and Latin-American NIC countries in the 1970s and early 1980s (Fagerberg, 2007, p. 710).

The model presented insofar is incomplete, since it disregards the role of international flows of goods and services and the balance of payments constraint that are the cornerstone of both the Thirlwall´s model (Thirlwall, 1979, 2002, 2013) as well as New-Developmentalist Model (Bresser-Pereira, Oreiro and Marconi, 2015).

For fixing this short come let us define S_X as the ratio of home exports (X) in world demand (W) and S_M as the ratio of home imports (M) in its own GDP (Y). Following Fagerberg (2007, p. 711), we will assume for the sake of exposition that the market shares of a country are unaffected by the growth of the market, but we will relax this assumption later. Following the Schumpeterian logic, we will also assume that, apart from a constant term, a country´s market share for exports depends on three factors: its technological competitiveness (its knowledge assets relative to competitors), its capacity to exploit technology commercially (again relative to competitors) and its price (*P*) competitiveness (relative to prices on tradables in common currency). So, we get:

$$S_X = A_3\left(\frac{Q}{Q_w}\right)^{\rho}\left(\frac{C}{C_w}\right)^{\mu}\left(\frac{P}{EP_w}\right)^{-\pi} \qquad (7)$$

Where: P is the level of home prices, E is the nominal exchange rate, i.e. the price of foreign currency in terms of home currency, P_w is the level of world prices.

Since, by definition, imports in this model are the world´s exports, we may model the import share in the same way, using bars to distinguish the coefficients of the two equations (Fagerberg, 2007, p. 711).

$$S_M = A_4 \left(\frac{Q_w}{Q}\right)^{\bar{\bar{\rho}}} \left(\frac{C_w}{C}\right)^{\bar{\bar{\mu}}} \left(\frac{EP_w}{P}\right)^{-\bar{\bar{\pi}}} \quad (8)$$

Taking logs and time derivatives of equations (7) and (8) we get:

$$s_x = \rho(q - q_w) + \mu(c - c_w) - \pi(p - e - p_w) \quad (7a)$$

$$s_m = \bar{\rho}(q_w - q) + \bar{\mu}(c_w - c) - \bar{\pi}(p_w + e - p) \quad (8a)$$

Equations (7a) and (8a) determine the growth rate of home exports and imports share.

Substituting (4) in (7a) and (8a) we arrive at the following expressions:

$$s_X = -\rho\gamma\phi\left[\frac{T - T_w}{T_*}\right] + \rho\lambda(n - n_w) + \mu(c - c_w) - \pi(p - e - p_w) \quad (9)$$

$$s_m = -\bar{\rho}\gamma\phi\left[\frac{T - T_w}{T_*}\right] + \bar{\rho}(n_w - n) + \bar{\mu}(c_w - c) - \bar{\pi}(p_w + e - p) \quad (10)$$

As we see in equations (9) and (10a), the growth of the market share of a country depends on four factors: (i) the potential for exploiting knowledge developed elsewhere, which depends on the country´s level of technological development relative to the world average; (ii) creation of new knowledge in the country (innovation) relative to that of competitors; (iii) growth in the ability to exploit knowledge, independently of where it is created, relative to that of competitors and (iv) change in relative prices in common currency (price competitiveness). (Fagerberg, 2007, p. 711).

So far, the model presented here does not have a balance of payments restriction. For open economies that do not have in international reserve currencies, the balance of payments is the main restriction to economic growth in the long-term (Oreiro and Costa Santos, 2023). Considering the simple case of an economy that does not have an open capital account, the balance of payments restriction is given by:

$$XP = EP_wM \quad (11)$$

Taking logs and time derivatives of (11) we get:

$$y = (s_X - s_m) + (p - e - p_w) + w \quad (12)$$

Equation (12) presents the growth rate of real output that is compatible with balance of payments constraint.

Substituting (9) and (10) into equation (12) and rearranging we arrive at the reduced form of the model:

$$y_{rel} = -(\rho + \bar{\rho})\phi\left[\frac{T - T_w}{T_*}\right] + (\rho + \bar{\rho})\lambda(n - n_w) + (\mu + \bar{\mu})(c - c_w) + [1 - (\pi + \bar{\pi})](p - e - p_w) \quad (13)$$

By comparing this with the similar reduced form of the growth model (6) we see that, apart from the last term on the right-hand side, the model has the same structure. The only difference is that the coefficients of the basic growth equation now are shown to be sums of coefficients for the similar variables in the market-share equations (for the domestic and world market). Hence, the sensitivity of the markets (or ´selection environments´ for new technologies clearly matters for growth. **The final term is the familiar Marshall-Lerner condition** which states the sum of the price-elasticities for exports and imports (when measured in absolute value) must be higher than one if deteriorating price-competitiveness is going to harm the external balance (Fagerberg, 2007, p. 712). This means that for a real exchange rate depreciation $(p - e - p_w) < 0$ to have a positive impact on relative income growth rates, that is, to increase the home growth rate of income relative to the rest of the world income growth, is necessary that $[1 - (\pi + \bar{\pi})] < 0$,

Up to now we had assumed that, apart from price, technology and capacity being considered as competitive factors, demand is assumed to have unitary elasticity of demand. This means, for instance, abstracting from other factors, that, if export demand grows by a certain percentage, exports will do the same, so that the market share remains unaffected. However, there are reasons to believe that this assumption, although appealing in its simplicity, does not necessarily apply in all cases. Indeed, it is only a special case. If a country has a pattern of specialization geared towards industries that are in high (low) demand internationally, the argument goes, its exports may grow faster (slower) than world demand, quite independently of what happens to other factors. Arguably this possibility might be expected to be of greatest relevance for small countries, since these are likely to be more specialized in their economic structure than large ones (Fagerberg, 2007, p.713).

The impact of trade specialization over income elasticities of exports and imports and hence over external constraint is the main characteristic of Latin-American Structuralism since the seminal work of Raul Prebisch (1949).More specifically, Prebisch argued that peripherical countries in Latin America had specialized in export of primary commodities which had low income elasticity of exports bur imports manufactured goods that had high income elasticity of imports. The result is that, except in periods of increasing prices of primary commodities, high growth of GDP in such countries is followed by fast deterioration in trade balance which, sooner or later, will provoke a balance of payment crisis and a sudden stop in economic growth. This idea was later formalized by Thirlwall (1979) with the so-called Thirlwall´s law which states that the long-run sustainable growth rate, i.e. the growth rate that is compatible with the balance of payments constraint, is given by the ratio of income elasticity of exports and imports multiplied by the rest of the world income growth.

To take this possibility into account, following Fagerberg (1988b), we introduce demand into the market shares equations as shown below:

$$S_X = A_3 \left(\frac{Q}{Q_w}\right)^{\rho} \left(\frac{C}{C_w}\right)^{\mu} \left(\frac{P}{EP_w}\right)^{-\pi} W^{\tau-1} \quad (14)$$

$$S_M = A_4 \left(\frac{Q_w}{Q}\right)^{\bar{\bar{\rho}}} \left(\frac{C_w}{C}\right)^{\bar{\bar{\mu}}} \left(\frac{EP_w}{P}\right)^{-\bar{\bar{\pi}}} Y^{\bar{\tau}-1} \quad (15)$$

Now we can see that in equation (14) the share of exports in world demand depends on the size of world demand and on the income elasticity of exports. If $\tau < 1$ then an increase in the world demand will be followed by a reduction in the share of home exports as a ratio of world demand; otherwise, the share of home exports will increase. Similarly in equation (15) we can see that the share of imports in home GDP depends on the level of home GDP and on the income elasticity of imports. If $\bar{\tau} > 1$ then an increase in home GDP will be followed by an increase in the share of home imports as a ratio of GDP; otherwise, the share of imports will decrease. It is well known that for middle- and high-income countries income elasticity of imports is higher than one, so for a high growth rate of real GDP to be sustainable in terms of balance of payments equilibrium income elasticity of exports must also be higher than one.

By, as done previously, taking logs, differentiating and substituting we arrive at the following expression for the reduced form:

$$y_{rel} = -\frac{(\rho+\bar{\rho})}{\bar{\tau}}\phi\left[\frac{T-\ T_w}{T_*}\right] + \frac{(\rho+\bar{\rho})}{\bar{\tau}}\lambda(n-n_w) + \frac{(\mu+\bar{\mu})}{\bar{\tau}}(c-c_w) + \frac{[1-(\pi+\bar{\pi})]}{\bar{\tau}}(p-e-p_w) + \frac{(\tau-\bar{\tau})}{\bar{\tau}}w \ (16)$$

According to Fagerberg (2007, p. 713) The first thing to note in equation (16) is that the higher the demand elasticity for imports, the lower the effect on growth of all other factors. This has to do with the requirement to keep external balance: the more import-intensive growth is, the harder it is to keep the balance in order. The second is that while, as before, the first three terms on the right-hand side resemble the basic Schumpeterian growth model expressed in (6), the last two terms in (16) concur with the model suggested by Thirlwall (1979). Hence, both the basic model (6) and Thirlwall´s model can be seen as special cases of a more general, open economy model, which is expressed in equation (16).

The open-economy model, outlined above, has been applied to empirical data for developed economies by Fagerberg (1988b). The empirical results, based on data for 15 OECD countries from the early 1960s to the early 1980s, generally confirmed the importance of growth in technological and productive capacity for competitiveness. The impact of cost factors was found to be relatively marginal, consistent with the earlier findings by Kaldor (the so-called `Kaldor paradox ´ see Kaldor, 1978).

3. Introducing Industrial Equilibrium Exchange rate in the Technological Gap Model.

As we had seen in the introduction, the original concept of industrial equilibrium exchange rate is that level of the exchange rate as that level of the exchange rate for which domestic companies operating with technology in the state of the world art manage to compete with foreign companies both in the domestic and international market (Bresser-Pereira, Oreiro and Marconi, 2015, p. 59). The problem with this definition, according to Oreiro (2022) and Oreiro and Martins (2019) is that most companies in middle-income countries do not operate with technology in the state of the world art, but behind the technological frontier. So, according to Oreiro (2022, p. 241) "the maintenance of the exchange rate at a level compatible with the so-called "industrial balance" is not sufficient to allow the development and expansion of companies in middle-income countries; it is thus necessary to implement industrial policies, science and technology and foreign trade that aim (i) gradually reduce the technological gap that separates domestic companies from their competitors in developed countries and (ii) ensure minimum conditions of survival and expansion for domestic companies while they do not reach the technological frontier. In this context, import tariffs can even be used for a limited and defined period of time, as a necessary instrument to ensure isonomic conditions for domestic companies in a context in which they have a significant technological lag with respect to their competitors abroad".

An alternative definition of industrial equilibrium exchange rate that incorporates the technological gap is given by Oreiro, Martins da Silva and Dávila-Fernandez (2020). For then "an overvalued exchange rate is associated with a negative process of structural change. In the context of developing economies, we may refer to it as premature deindustrialization (…) The problem is that firms in countries such as Brazil or Argentina generally operate behind the technological frontier. Therefore, we redefine the industrial equilibrium exchange rate as the one that, for a given level of technological gap, makes the share of manufacturing industry constant over time. Furthermore, it must be noticed that the existence of such a technological gap negatively affects the non-price competitiveness of manufacturing firms. Manufactured goods produced in such countries are frequently of inferior quality and/or lower technological intensity" (Ibid, p. 31).

Oreiro, Martins da Silva and Dávila-Fernandez (2020) proposes that the dynamics of manufacturing share on output for developing or middle-income countries is given by the following equation:

$$\frac{\dot{\gamma}}{\gamma} = \beta_0 + \beta_1\theta - \beta_2 GAP \quad (17)$$

Where: θ is the level of real exchange rate and GAP is the technological gap.

It is important to notice that $\beta_0 < 0$ is a parameter that captures the effect of a *natural deindustrialization* when due to growing per-capita income, the share of manufacturing goods in households' consumption diminishes because of increasing consumption diversification towards services (Rowthorn and Ramaswany, 1999). The parameter $\beta_1 > 0$ represents *discretionary policies* that directly address industrial development through *price competitiveness*; and the parameters $\beta_2 > 0$ corresponds to the sensitivity of the manufacturing share to *non-price competitiveness* which is represented by the technological gap. Parameter β_1 implicitly captures the effects of trade-tariffs on the manufacturing sector. A high level of tariffs reduces the response of the manufacturing share to real exchange rate because it implies a lower substitutability between domestic and foreign goods.

For calculating the industrial equilibrium exchange rate, we must set $\frac{\dot{Y}}{Y} = 0$ in equation (17). Then we get:

$$\theta^{IND} = \frac{\beta_0 + \beta_1 GAP}{\beta_2} \quad (18)$$

In equation (18) we can see firstly that the higher is the level of the technological gap, higher will be the level of real exchange rate required to stabilize the manufacturing sector. This is a very intuitive result. As we already see, technological gap is a proxy for non-price competitiveness and real exchange rate is a proxy of price competitiveness of manufacturing sector. A decrease in non-price competitiveness, i.e. an increase in the technological gap, must be compensated by an increase in price competitiveness, i.e. an exchange rate devaluation, to keep the share of manufacturing sector in GDP constant over time.

For introducing the industrial equilibrium exchange rate in the model presented in the last section let us define the technological gap as:

$$GAP = \left[\frac{T - T_w}{T_*}\right] \text{ (19)}$$

Where: T is the home country technological knowledge adjusted by its GDP, T_* is the level of knowledge in the technological frontier and T_w is the rest of the world average technological knowledge adjusted by its GDP.

A technological backward country can be in two different situations. The first one occurs when $(T - T_w) > 0.$ In this case, although the home country is behind technological frontier, it is ahead of world average, so $GAP > 0$. The second one occurs when $(T - T_w) < 0$, so the home country is not only a technological backward country, but it is also backward relative to the average of other countries in the world. In this case the technological gap must be defined as $GAP = -\left[\frac{T_w - T}{T_*}\right]$. This means that the effect of technological gap over relative growth in equation (16) is non-linear. In the first case, a reduction in the technological gap is associated with an increase in relative growth rate of home country, but on the second case a decrease in technological gap will be associated with a decrease in relative growth rate of home country. The intuition behind this result is straightforward. The capacity to exploit the benefits of technological diffusion from abroad depends on the distance of the home country relative to the technological frontier. A backward country that had a technological knowledge superior to the average of the rest of the world would have less benefits to exploit than a country to is below the world average. This means that the more backwardness a country is, all other things constant, more technological spillovers are available to the country and hence higher will be the rate of technological diffusion (Fagerberg, 2007, p.709).

From equation (18) we get:

$$GAP = \frac{\beta_2 \theta^{IND} - \beta_0}{\beta_1} \quad (20)$$

In equation (20) we can see that exists a positive relationship between technological gap and the level of industrial equilibrium real exchange rate. This means that an appreciation of industrial equilibrium real exchange rate is associated with a reduction of technological gap.

Substituting (19) into (20) and the resulting equation into (16) we get:

$$y_{rel} = -\frac{(\rho + \bar{\rho})}{\bar{\tau}} \phi \left[\frac{\beta_2 \theta^{IND} - \beta_0}{\beta_1} \right] + \frac{(\rho + \bar{\rho})}{\bar{\tau}} \lambda (n - n_w) + \frac{(\mu + \bar{\mu})}{\bar{\tau}} (c - c_w) + \frac{[1 - (\pi + \bar{\pi})]}{\bar{\tau}} (p - e - p_w) + \frac{(\tau - \bar{\tau})}{\bar{\tau}} w \quad (21)$$

The rate of change of real exchange rate $\hat{\theta}$ is given by:

$$\hat{\theta} = e + p_w - p \quad (22)$$

According to New-Developmentalist model the rate of change of real exchange rate in an economy that suffers from Dutch Disease, but not from foreign growth model, is determined by the difference between the current account equilibrium exchange rate (θ^{CAB}) and the industrial equilibrium exchange rate (Oreiro, Martins da Silva and Dávila-Fernandez, 2020, p. 34). So, we get:

$$\hat{\theta} = \sigma(\theta^{CAB} - \theta^{IND}) \quad (23)$$

Replacing (23) into (22) and the resulting equation into (21) we get:

$$y_{rel} = -\frac{(\rho+\bar{\rho})}{\bar{\tau}}\phi\left[\frac{\beta_2\theta^{IND}-\beta_0}{\beta_1}\right] + \frac{(\rho+\bar{\rho})}{\bar{\tau}}\lambda(n-n_w) + \frac{(\mu+\bar{\mu})}{\bar{\tau}}(c-c_w) + \frac{[1-(\pi+\bar{\pi})]}{\bar{\tau}}\sigma(\theta^{CAB}-\theta^{IND}) + \frac{(\tau-\bar{\tau})}{\bar{\tau}}w \quad (24)$$

Equation (24) is the reduced form equation of the Schumpeterian-Post-Keynesian-New-Developmentalist model. In this equation we can see that the level of real exchange rate and the rate of change of real exchange rate had two different effects over relative growth rate (Rapetti, 2020). An appreciation of industrial equilibrium exchange rate is associated with an increase in the relative growth rate of home country since it is the result of a reduction in the level of technological gap. This behaviour seems full compatible with the empirical regularities found by Kaldor (1978). Countries that are well succeed in climbing the technological ladder are also the countries where labour force is transferred from low added-value activities to high added-value activities where wages are also higher. This explains why successful manufacturing export countries are precisely the same where unit labour costs increase relative to other countries.

For a given level of technological gap, and hence of industrial equilibrium exchange rate, however, a overvaluation of real exchange rate due for Dutch Disease $(\theta^{CAB}-\theta^{IND}) < 0$ is associated with a lower relative growth of home country, since $\frac{\partial y_{rel}}{\partial(\theta^{CAB}-\theta^{IND})} = \left(\frac{[1-(\pi+\bar{\pi})]}{\bar{\tau}}\sigma\right) < 0$.

So, the model presented here is capable to reconciliate the role of real exchange rate in the process of economic development with the empirical findings of Kaldor (1978). For analysing the effect of real exchange rate in economic growth is important to distinguish between the level and the rate of change of real exchange rate, as noted by Rapetti (2020).

4. Final Remarks

Through out this article we had show that the so-called Kaldor´s paradox is not incompatible with the negative role that real exchange rate overvaluation had over economic development of middle-income countries according to New-developmentalism. As a matter of fact, one had to distinguish between the level and the rate of change of real exchange rate, as suggested by Rapetti (2020). If the level of real exchange rate, represented by industrial equilibrium exchange rate, is determined by technological gap; then an appreciation of exchange rate is associated with an increase in relative growth of home country and hence with a process of catching up with high income countries. Dutch disease, however, is a situation in which real exchange rate is not constant overt time but appreciates relative to the industrial equilibrium level. This means that, given the level of technological gap, there will be an exchange rate overvaluation that had harmful effects over economic growth in the medium to the long term.

These results had very powerful policy implications for economic development. First, the traditional industrial and science and technology policies can be not enough for inducing a process of catching up if a country had a macroeconomic policy regime that do not neutralize Dutch Disease and hence allowed a real exchange rate overvaluation. This means that economic development cannot be separated from macroeconomics, neither at theoretical nor policy making aspects. Moreover, a developing country that wants to catch up with high income countries must design a macroeconomic policy regime for targeting real exchange rate at industrial equilibrium level. For that, the country must be able to determine policy interest rate and nominal exchange rate independent one from another. This necessarily requires the use of capital controls; other wise it will be impossible to manage exchange rate and have an autonomous monetary policy at the same time as it is established by Mundell impossible trinity (Boughton, 2003).

Second, if the technological gap is increasing over time, as it happens in Brazil from 1998 to 2017 (Oreiro, Manarin D´Agostini and Gala, 2020), to keep the real exchange rate at industrial equilibrium level can be an impossible task in terms of both economic policy and political economy. In terms of economic policy an increasing technological gap means an increasing industrial equilibrium real exchange rate which will demand a continuous process of nominal exchange rate devaluation that will produce inflationary pressures. In terms of political economy, keep real exchange rate devaluating over time means reducing real wages which can be unacceptable for workers and their labour unions. This means that the political coalition necessary for adopting developmental policies can be disintegrated.

To sum-up, economic development is a very hard process that demands both sound macroeconomic policies as well as well-designed industrial and science ant technology policies. This requires a class coalition (Oreiro, 2024) that can be no easy to build.

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